

Barriers and Opportunities to Broader Adoption of Integrated Demand Side Management at Electric Utilities

A Scoping Study

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Glossary of Terms

Aggregator: An intermediary retailer between an energy supplier and its customers. Also referred to as Aggregators of Retail Customers (ARCs).

Ancillary Services: Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice. (From FERC order 888-A.)

Automated Demand Response (ADR): Preprogrammed technical control strategies at a customer site. ADR involves installation of advanced control and communication programs where an automated signal from the dispatcher (e.g. utility) triggers a pre-defined response from the customer's end-use.

Behind-the-Meter (BTM) Storage: Energy storage devices such as batteries that are on the customer's premise and metered electrical system. These devices are owned and operated by the customer or a third party that has been contracted by the customer. This is in contrast to utility- or grid-scale storage that is owned and operated by a utility provider.

Capacity: A power rating for generation or demand response. Often the maximum amount of power able to be supplied by the electric grid at any time or the maximum load that a generating unit or generating station can carry under specified conditions for a given period of time without exceeding approval limits of temperature and stress. Other usages include: to describe peak net load, i.e. the maximum need for generation from dispatchable energy resources; to describe a service that reduces the maximum generation ability needed (e.g. "Demand response has the potential to provide capacity").

Controllable Demand Response Opportunities: Programs that provide a utility or ARC with the opportunity to directly control (via radio, internet, telemetry or other remote means) various customers' electricity consuming end-uses (e.g., electric water heaters, pool pumps) or some portions of their load which could be increased, decreased or even physically disconnected from the grid with little to no notice.

Critical Peak Pricing (CPP): Rates that institute a single or variable predetermined price for electricity during a narrowly defined period (e.g., summer weekday between 4 PM and 7 PM) that is only applied during specific system operating or market conditions and generally limited in the number of times it can be dispatched (e.g. twelve times per year).

Distributed Energy Resources (DERs): A source or sink of power that is located on the distribution system, any subsystem thereof, or behind a customer meter. These resources may include, but are not limited to, electric storage resources, distributed generation, demand response, thermal storage, and electric vehicles and their supply equipment.

Demand Response (DR): Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

Enabling Technology: A set of on-site hardware and software that enables a particular end-use or set of end-uses to provide DR service across one or more products.

End-Use: A service performed using energy (e.g. lighting, refrigeration) or a type of energy-using devices (e.g. refrigerators, pool pumps). These end-uses and their demand for electricity make up customer load.

Flexible Loads: End-use load that is able to change its demand profile for DR purposes. This may refer to the total load of the given end-use or some fraction of the total load that is able to be modified. For example, only half of a customer's HVAC load may be "flexible", as the portion providing the ventilation services may be required to stay on at all times.

Integrated Demand Side Management: The integration/coordination of program delivery for three or more of: (1) Energy Efficiency, (2) Demand Response, (3) Distributed Generation, (4) Storage, (5) Time-based Rates, and (6) Electric Vehicle programs.

Internet of Things (IoT): The inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data over a network without requiring human-to-human or human-to-computer interaction .

Investor-Owned Utility (IOU): A business organization providing utility service(s) that is managed as a private enterprise rather than a function of government or a utility cooperative.

Open Automated Demand Response (OpenADR): An open and interoperable information exchange model and communication standard. OpenADR standardizes the message format used for ADR controls, gateways, and energy management systems to enable standardized communication of price and DR signals between customer facilities and utilities, Independent System Operators (ISOs), or Energy Service Providers.

Program Administrator: An entity that maintains primary responsibility and accountability for the design, administration, and delivery of customer-facing demand side management programs that are funded by the public and/or ratepayers. Program administrators can include utilities or independent administrators that are contracted through a state regulatory entity.

Sector: A market or population segment sharing common characteristics. For the purposes of this study, the relevant sectors are: residential, commercial, and industrial (which includes agriculture).

Time-Based Rates (TBR): Electricity rates paid by customers in which rates vary for different days, times of the day, or events (such as days with extremely high loads). The electric utility alters the price level charged to retail customers for electric commodity purchases in order to elicit a change in electricity consumption. While TBRs are not universally considered DSM programs per se, many utilities consider TBR to be the foundation for DSM and IDSM program adoptions.

Variable Peak Pricing (VPP): A hybrid of time-of-use and real-time pricing where the different periods for pricing are defined in advance (e.g., on-peak=4 hours for summer weekday afternoon; off-peak= all other hours in the summer months), but the effective price for the on-peak period varies by market conditions and prices.

Executive Summary

Demand-sideⁱ management (DSM) is the planning and implementation of programs designed to influence electric and gas utility customer uses of energy in ways that will produce desired changes in a utility's or customer's energy profile (Gellings, 1985). This scoping study focuses solely on ratepayer-funded DSM programs designed to change electricity consumption patterns of end-use customers over the short- or long-term through improving energy efficiency and optimization of electric power demand. Historically, in the electric industry, DSM programs administered by utilities or other providers fell into one of two general program types: energy efficiency (EE) and demand response (DR) (Ghatikar et al., 2012). However, in recent years, the concept of DSM has expanded beyond EE and DR to include customer-sited distributed energy resource (DER) technologies. The availability and decreasing cost of DER technologies has changed the types of DSM opportunities available to customers, and the potential solutions for program administrators responsible for implementing DSM programs.

Regulators and policymakers have instituted a patchwork of policies to encourage the adoption of the myriad technologies and strategies (e.g., behavior-based programs) that comprise DSM. Their efforts have taken a number of different approaches including regulatory or legislative mandates (e.g., Energy Efficiency Resource Standards), expansion of the use of integrated resource planning (IRP) or the prioritization of demand-side resources in resource planning efforts. Another approach to increasing the adoption of DSM, with which the industry has limited experience to date, is promoting the integration of DSM program delivery to customers – the main topic of this report.

Integrated demand side management (IDSM) at a conceptual level is a strategic approach to designing and delivering a portfolio of DSM programs to customers that provides benefits to both participating customers (i.e., lower bills) and non-participants (i.e., resource benefits). IDSM programs typically deliver customer centricⁱⁱ strategies with the goal of increasing the amount of DSM in the field, but doing so in a way that integrates various measures and technologies to improve their collective performance and/or penetration.

Most utility and 3rd party administrator programs currently identified with the concept of IDSM only integrate two DSM measures, namely EE and DR. For our purposes, however, we define the concept of IDSM as follows, recognizing that its application at present is highly limited, suggesting that it is both aspirational and forward looking:

“The integration/coordination of the delivery for three or more of: (1) Energy Efficiency, (2) Demand Response, (3) Distributed Generation, (4) Storage, (5) Electric Vehicles, and 6) Time-Based Rate programs for residential and commercial electric utility customers.”

ⁱ “Demand-side” refers to activities that involve the end-use customer’s energy usage as opposed to the “supply side” which refers to utility energy generation, transmission and distribution activities.

ⁱⁱ For the purpose of this paper, customer centric refers to focusing on specific customer characteristics, either individually or within a larger group that shares similar demographic and energy usage profiles.

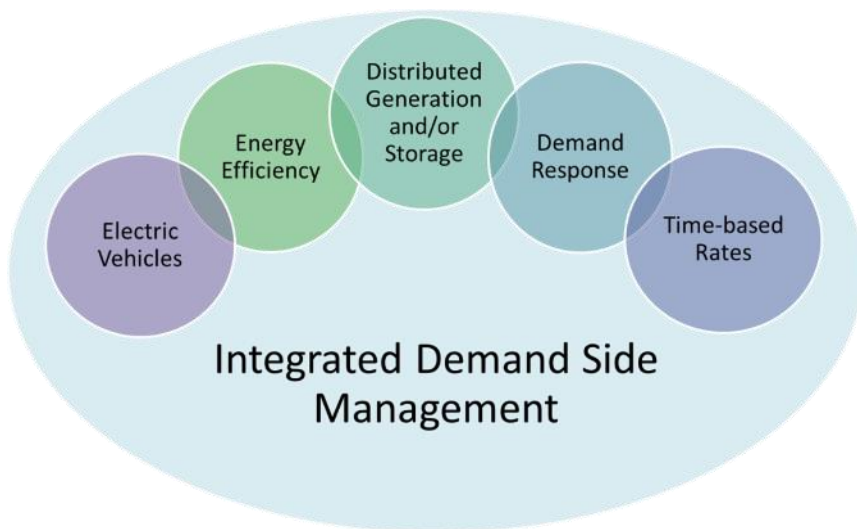


Figure ES-1: Illustration of the Program Types Included in IDSM

Figure ES-1 provides an illustration of the DSM components and their relationship within the umbrella of IDSM. Three of the five DSM components must be offered as an integrated solution in order to qualify as IDSM based on our definition. A utility can offer several IDSM programs and portfolios that include three or more DSM components, and a customer can select various measures from within the offerings. For this study, the discussion and definition of IDSM is limited to include electric utility program delivery and the electric utility rates. Time-based rates are included in the definition of IDSM as they are often used to augment or support the value of IDSM by sending price signals to devices or customers that have installed DSM technologies and measures. Additionally, behavior-based programs can fall under the rubric of EE and/or DR, depending on their design, while retro-commissioning and new construction programs typically fall under the EE program umbrella.

Although not discussed in this paper, some consider IDSM efforts as inclusive of approaches that meet very specific grid needs (e.g., deferring distribution system upgrades or managing the impacts of generation retirements) by procuring any or all DSM technologies that can meet that particular need cost-effectively. For example, several states (e.g., California, New York, Washington, Massachusetts and Maine) have or are pursuing Non-Wires Alternatives (NWAs) opportunities to address load growth and aging infrastructure by using DSM to defer or replace the need for specific equipment upgrades, such as T&D lines or transformers, by reducing load at a substation or circuit level (DeAngelo et al., 2017). They have all engaged in competitive bidding processes for procuring demand side resources. However, these competitive solicitations did not necessarily result in deploying IDSM resources that followed the definition presented in this paper, but rather used a coordinated approach in the procurement of any DSM technology that met a specific system need. From the perspective taken in this report, IDSM can fit under the umbrella of NWA as it aims to address targeted distribution system constraints with DSM opportunities. The value proposition of NWA could be extended to IDSM programs and promote the rationale for pursuing integrated portfolios of measures. However, these competitive solicitations currently do not result in deploying customer-facing IDSM programs that followed the definition presented above, but rather procure any eligible DSM resource that meets a specific system need.

This scoping study explores recent electric utility industry experience with IDSM to provide an updated assessment of any benefits and barriers observed by a sample of industry practitioners. To better

understand the current status of IDSM efforts in the electric utility industry and where it is likely headed in the near future, we gathered input from entities who are currently managing, or planning to implement IDSM. We reached out to ten such entities to ask if they would participate and provide information for our study. Eleven staff from eight utility and third-party program administrators responded and participated in the data gathering exercise used to inform this study.ⁱⁱⁱ Thus it is important to note that the focus of this scoping study is on electric utility IDSM efforts from interviews conducted with a small sample of utilities and one program implementer, which narrowly focuses the viewpoints represented herein. Our primary data collection method was a survey instrument, with follow-up interviews of some respondents to clarify responses. We organize this scoping study by examining the categories of regulatory and program administrator/implementer IDSM drivers, barriers, and opportunities for electric utilities and their customers.

We asked the program administrators to provide information on the business drivers for IDSM within their organization. All of the respondents agreed that IDSM programs have a purpose in their businesses and that there are common drivers for increasing or implementing IDSM portfolios. Nearly all of the respondents indicated that the IDSM portfolio benefits include compliance with regulatory mandates to offer IDSM portfolios and the ability to increase the number of DSM measures that are capable of optimizing customers' end use consumption. Over 80% of the respondents agreed that reducing the market confusion that customers might experience about different demand side program offerings was a motivator for implementing IDSM portfolios. Approximately 75% of all respondents stated that IDSM can increase customer engagement and satisfaction, while two-thirds of the utility respondents believe that IDSM can improve the cost-effectiveness of program delivery.

The program administrators were asked to indicate the level of significance associated with a list of regulatory barriers to offering or expanding IDSM programs and portfolios found in the literature. A majority of the respondents identified the separation of existing utility DSM program budgets as the most significant barrier to the successful implementation of IDSM. A lack of effective metrics for evaluating cost-effectiveness was considered as being a very significant or the most significant barrier by roughly half of the respondents. Five of the 11 respondents felt that a lack of integrated EM&V rules, as well as the diversity of entities delivering DSM, were also very significant barriers.

When asked to consider the program administration barriers for expanding IDSM, the respondents believed that the single biggest barrier to offering or expanding IDSM activities was the separation of responsibilities within their organizations for delivering different DSM technologies - eight out of 11 said it was either very significant or the most significant barrier. Almost all of the respondents reported that they have undertaken one or more activities within their own organization to address various barriers to offering IDSM portfolios, but only one activity has been attempted by a majority of respondents – consolidation of organizational responsibility for delivering DSM technologies.

The program administrators that we surveyed and interviewed identified a number of opportunities to further expand IDSM efforts. Specifically, program administrator respondents saw the most important regulatory reforms as those that would address the top three most significant barriers, which were: 1) effective metrics for evaluating cost-effectiveness; 2) separate and distinct program budgets; and 3) regulatory rules that do not provide a holistic approach for EM&V. Additionally, our sample of program administrators supported the bundling of EE, DR and other DSM technologies within their organization,

ⁱⁱⁱ Respondents were from the following organizations: Sacramento Municipal Utility District, Consolidated Edison, DTE, Avangrid, Southern California Edison, Pacific Gas & Electric, Hawaiian Electric Company, Hawaii Energy

as an IDSM program of these measures has the potential to improve the cost-effectiveness of IDSM for customers and program administrators, as well improving the operation of end uses at the service premise.

From the perspective of those program administrators who participated in our study, deployment of more complex IDSM programs over the next few years can be expected. We asked the program administrators who participated in our study to consider what specific mix of measures and technologies have the most potential for adoption in an IDSM portfolio in the near future (see Table ES-1 for residential programs and Table ES-2 for commercial and industrial customer programs). The first column lists the strategies (e.g., end-use measures, programs) that the program administrator respondents listed as the most promising opportunities and technologies for an IDSM portfolio. In the second column, we provide a description of those strategies, most of which are available today. These IDSM strategies can provide flexible energy management, as described in the Program/Measure Description column, and could potentially provide value to the customer, program administrator, and grid if integrated successfully.

Table ES-1: Promising Residential IDSM Programmatic Opportunities

Strategy	Description
Home Retrofit	Home retrofits programs that include incentives for a bundle of DSM improvements including, but not limited to: home weatherization, appliance upgrades, lighting retrofits, installation of technologies that enable demand response (e.g. home energy management systems and sensors, PCT), EV charging panel, and DG.
HVAC Controls	Wi-Fi connected programmable communicating thermostats can be enabled to receive a DR signal during an event, provide the customer with long-term efficiency savings, and respond to time-based rates via automated controls and sensors.
Water Heating	Heat pump water heaters (HPWH) use electricity to move heat from one place to another instead of generating heat directly. Therefore, they can be two to three times more energy efficient than conventional electric resistance water heaters. Additionally, HPWH have demonstrated that they are capable of providing demand response services. Grid-interactive water heaters (GIWH) adds bi-directional controls to electric resistance water heaters, and are capable of allowing the utility or third-party aggregator to rapidly and repeatedly turn them on and off, or incrementally ramp their power up and down. This control creates an opportunity to utilize the GIWH as a thermal storage unit that can respond on demand to dispatch signals.
Electric Vehicles	Electric vehicles and smart chargers are promising technologies that can be coordinated with time-based rates (TBR) to receive price signals or demand response programs which dispatch control signals to charging stations. The charging stations can respond to price or program signals by increasing or decreasing load in response to grid needs, and can be paired with solar PV or storage systems for more optimal charging behaviors.
Advanced Solar Inverters	Smart solar inverters that are capable of sending and receiving data from the utility or third-party aggregator systems and providing advanced grid functions, such as ramp rate control, power curtailment, fault ride-through and voltage support.
Battery Storage	Battery storage was cited by all participants as the most promising IDSM technology. Battery storage combined with DG could provide greater grid stability and optimize behind the meter resources. If paired with a time-based rate, storage can also take advantage of energy arbitrage opportunities.

Table ES-2: Promising Commercial and Industrial IDSM Programmatic Opportunities

Program/Measure Description	
Lighting Systems and Controls	Networked Lighting controls in commercial buildings can provide dramatic energy reductions, in particular during evening hours when the buildings become vacant and workers go home. Networked controls use sensors to maintain lighting only where there is occupancy and can also be used to control lighting during DR events, using dimming and daylight harvesting strategies, and/or in response to TBR.
Retro-Commissioning	Retro-commissioning programs begin with an audit of the entire facility to determine what equipment and envelope measures need to be addressed. IDSM opportunities for retro-commissioning can offer incentives for EE measures (e.g. lighting retrofits, building automation upgrades, HVAC improvements, variable frequency drives), demand response technologies, and DG (if applicable)
Energy Management Control Systems	Building Automation Systems (BAS) or commercial Energy Management Control Systems (EMCS) are computerized control systems that regulate the energy consumption of a building by controlling the operation of end-uses, such as the heating, ventilation and air conditioning (HVAC), lighting, and water heating systems. This creates numerous opportunities for more efficient operations, control during DR events, and response to TBR.
Battery Storage	Battery storage was cited by all participants as the most promising IDSM technology. Battery storage combined with DG and DR could provide greater grid stability and optimize behind the meter resources. If paired with a time-based rate, storage can also take advantage of energy arbitrage opportunities.
Electrified Public Buses	Electrified public bus transportation is noted as an opportunity to change the fuel source of public transportation and utilize the buses as energy resources on the grid, such as charging mid-day when solar production is highest, through either DR or TBR. This also creates opportunities for greater efficient use of energy, writ large.

In summary, although a number of factors could support broader pursuit of IDSM, the respondents identified and prioritized a number of barriers that may stymie their ability to expand IDSM offerings. They indicated that it will require both internal and external efforts (i.e., executive management and regulatory support) to adequately address these barriers and subsequently capture the benefits that IDSM enables. Respondents acknowledge this is a critical time for addressing EE, DR and DER optimization, and that IDSM may be positioned to play an important role in ensuring that customer DSM investment supports the grid's evolving needs.

1. Introduction

Demand-side¹ management (DSM) is the planning and implementation of programs designed to influence electric and gas utility customer uses of energy in ways that will produce desired changes in the utility's energy profile (Gellings, 1985). This scoping study focuses solely on ratepayer funded DSM programs designed to change electricity consumption patterns of end-use customers over the short- or long-term through improving energy efficiency and optimization of electric power demand. In contrast to traditional electricity management which alters supply to meet demand, DSM aims to balance supply by reducing or shifting the electric demand. Therefore, DSM can potentially postpone the construction of new generation, transmission, and/or distribution infrastructure (Han and Piette, 2008). Historically in the electric industry, DSM programs administered by utilities or other providers have fallen into one of two general program types: energy efficiency (EE) and demand response (DR) (Ghatikar et al., 2012).

EE generally refers to long-lasting or permanent reduction of energy consumed (kWh) while receiving the same or increased level of energy services. Energy efficiency can also permanently reduce peak demand (Kiliccote et al., 2014). U.S. utilities began delivering EE programs to customers in the 1970s amid concerns about energy price shocks, dependence on foreign oil and the environmental impacts of electricity generation. The passage of the National Energy Conservation Policy Act of 1978 (NECPA), which required all investor-owned utilities to offer energy audits to residential customers, marked the beginning of modern EE programs (Eto, 1996). From there, state regulators and policymakers began to promote the expansion of utility EE offerings through a series of policy reforms including the provision of dedicated program budgets, implementation of lost revenue mechanisms and the application of shareholder incentive mechanisms for successful achievement of certain programmatic goals (NAPEE, 2007).

In contrast to EE, DR is time-dependent and focuses on reducing energy demand (kW) at certain times or shifting customers from their normal energy use patterns in response to changing electricity prices or grid reliability needs (DOE, 2006). It aims to resolve the imbalance between electric supply and demand quickly through the elasticity of electricity demand (Han and Piette, 2008). The first demand response programs were introduced in the 1950s and 1960s as electric utilities began to look to its largest commercial and industrial customers to support reliability at the bulk power system level (EDP, 2016). Over time, the types of demand response opportunities offered by electric utilities evolved by expanding the types of utility customers who qualified as resources (e.g., smaller commercial, residential) as well as the approaches taken to modify load (e.g., voluntary load response, mandatory controlled response) (Cappers et al., 2011). The advent of organized wholesale markets in the early 2000s facilitated a role for DR resources to provide a significant portion of bulk power system services (IRC, 2016).

In recent years, the concept of DSM has evolved beyond EE and DR to include customer-sited distributed energy resource (DER) technologies. NERC defines a DER as “any resource on the distribution system that produces electricity and is not otherwise included in the formal NERC definition of the Bulk Electric System (BES)” (NERC, 2017). NERC specifies that DER must be a generation source (e.g., renewable energy generation, storage, backup generation but not DR or EE) and can be behind

¹ “Demand-side” refers to activities that involve the end-use customer’s energy usage as opposed to the “supply side” which refers to utility energy generation, transmission and distribution activities.

the meter or on the distribution network.² In contrast, a report for the New York ISO (NYISO) defines DER as pertaining specifically to behind the meter (BTM)³ customer-sited power generation and storage resources (DNV-GL, 2014). However, the New York State PSC defines DERs more broadly to include energy efficiency and demand response (NYPSC, 2015a). By expanding the definition of DSM, there is a recognition that a number of new resources can provide complimentary and/or similar services to the grid as traditional DSM resources.⁴

Over the last ten years, the increasing availability and decreasing cost of DER technologies has changed the types of DSM opportunities available to electric utility customers, and the potential solutions for program administrators responsible for implementing DSM programs. DSM technologies have become increasingly more sophisticated; many include two-way communication embedded in end-use measures that allows for remote control of energy consumption (e.g. AutoDR controls in HVAC and programmable communicating thermostats). For DSM program administrators, the collection of resources available to help customers manage their energy consumption continues to expand with end-use measure technology advancements and declining costs for DERs. This trend, especially in combination with declining costs in DERs,⁵ is invoking attention to new solutions for optimizing energy consumption behind the meter.

Regulators and policymakers have instituted a variety of policies to encourage the adoption of the myriad technologies and strategies (e.g., behavior-based programs) that comprise DSM. Their efforts have taken a number of different approaches.

Many states have set savings levels goals or enacted policies requiring the acquisition of certain types of DSM technologies, or both. For example, many state legislatures have enacted energy efficiency resource standards (EERS).⁶ An EERS sets long-term energy savings targets for utilities or third-party program administrators that must be met through EE programs. The EERS requires that a program administrator achieve annual (or cumulative) savings that represent a specified percentage of energy sales in a baseline year. Texas was the first state to adopt an EERS in 1999; more states followed suit in the early to mid-2000s (ACEEE, 2017).⁷ As of January 2017, twenty-four states have established EERS policies for electric utilities. Two states allow energy efficiency to count toward renewable energy standards (RES) and seven states call for procuring all cost-effective energy efficiency. Most EERS provide for increasingly stringent targets over time. For example, Arizona's incremental savings target started at 1.25% of retail electricity sales in 2011, then ramps up to 2.5% of sales annually in 2016 and remains at 2.5% through 2020, for cumulative savings of 22% of sales. Four states' EERS allows peak demand reductions to count toward the goal, or include separate peak reduction goals (AZ, MD, PA, and TX).⁸

² For this paper, we adopt NERC's definition of DERs.

³ Behind the meter generally refers to generation or storage resources that are connected behind the customer retail access point (the meter), as opposed to connected on the bulk power system.

⁴ Hereafter we refer to DSM as an umbrella term for EE, DR and DER technologies. Again, we adopt NERC's definition of DERs for this paper.

⁵ For example, the installed price of residential solar PV systems has declined an average of 7% annually from 2000 to 2016 (Barbose et al., 2017).

⁶ These can also be called energy efficiency portfolio standards (EEPS).

⁷ States that first enacted EERS between 2000 and 2007: CA, CO, CT, HI, IL, MN, NC, NC, PA, VT, WA.

⁸ While not within the scope of this study, it is worthwhile to consider future research that evaluates whether those states that allow EERS to be met with peak reduction have a greater alignment of utility EE and DR programs.

Many states have also introduced or expanded the use of long-term integrated resource planning (IRP), an evolution of the early least-cost planning⁹ concept that sought to identify and procure electricity resources from a range of resource options including both generation and demand-side resources, to maintain adequate electricity supply and system reliability at least cost. Under IRP, planners consider a broader range of resource alternatives including generating capacity (e.g., thermal, renewable, and customer-owned), investing in transmission and distribution lines, and implementing DSM programs (Wilson and Biewald, 2013). As of 2013, 34 states had established IRP rules or passed legislation requiring utilities to submit IRPs inclusive of demand-side resources (Barbose et al., 2013).

In addition, some policymakers called for the prioritization of demand-side resources in electricity resource planning efforts. For example, in 2003 California energy agencies established a “loading order” for electricity resources that calls for decreasing its per capita energy demand via energy efficiency first, demand response activities second, and then for meeting new generation needs with renewables and DER – before considering new generation from fossil fuel sources (State of California, 2003).

Once planning efforts have identified a system need that DSM can help address (e.g., deferring distribution system upgrades or managing the impacts of generation retirements), such utilities procure any or all DSM technologies able to meet that particular need cost-effectively. As a recent example, several states (e.g., California, New York, Washington, Massachusetts and Maine) have or are pursuing Non-Wires Alternatives (NWAs) opportunities to address load growth and aging infrastructure using DSM to defer or replace the need for specific equipment upgrades, such as T&D lines or transformers, by reducing load at a substation or circuit level (DeAngelo et al., 2017). They have all engaged in competitive bidding processes for procuring demand side resources from a range of third-party market providers.

Another approach to increasing the adoption of DSM, with which the industry has limited experience to date, is promoting the integration of DSM program delivery – the main topic of this report.

Integrated demand side management (IDSM) at a conceptual level is a strategic approach to designing and delivering a portfolio of DSM programs to customers that provide benefits to both participating customers (i.e., lower bills) and non-participants (i.e., resource benefits). IDSM programs typically deliver customer-centric¹⁰ strategies with the goal of increasing the amount of DSM in the field, but doing so in a way that integrates various measures and technologies to improve their collective performance and/or penetration.

Most programs currently identified with the concept of IDSM only integrate two DSM measures, namely EE and DR. For our purposes, however, we define the concept of IDSM as follows, recognizing that its application at present is highly limited, suggesting that it is both aspirational and forward looking (see Figure 1)¹¹:

⁹ In the late 1970s energy efficiency advocates introduced the concept of “least-cost planning”, supported by research that found saving energy could be done at much lower cost than the building of new power plants (Eto, 1996).

¹⁰ For the purpose of this paper, customer-centric refers to focusing on specific customer needs, either individually or within a larger group that shares similar demographic and/or energy usage profiles.

¹¹ As a part of our research, we presented program administrators several definitions of IDSM and asked how they would define the concept. Ninety percent of respondents’ definition aligned with the definition we have identified for this report. More about the survey instrument, the respondents and the results are discussed in the body of the report.

“The integration/coordination of delivery for three or more of: (1) Energy Efficiency, (2) Demand Response, (3) Distributed Generation, (4) Storage, (5) Electric Vehicle, and (6) Time-Based Rate programs to residential and commercial electric utility customers.”

One of the key components within our definition of IDSM is the suite of technology measures utilized in the program offerings. Many enabling technology end-uses have technical capabilities that allow the end-use to achieve multiple DSM objectives. For example, a programmable communicating thermostat (PCT)¹² is an ideal IDSM program measure when paired with a time-based rate (TBR), as it achieves EE savings (i.e., overall energy savings), is DR ready (i.e., controllable demand reduction), and can simplify the customer’s response to TBR with the device’s programmability. Another example would include variable air volume (VAV) system controls in HVAC systems enabled with ADR and OpenADR¹³, which also can provide EE savings while offering load shedding and shifting capabilities when implemented with a TBR (Alstone et al., 2017). End uses and measures that include technologies capable of delivering more than one type of DSM service can be key components of IDSM.

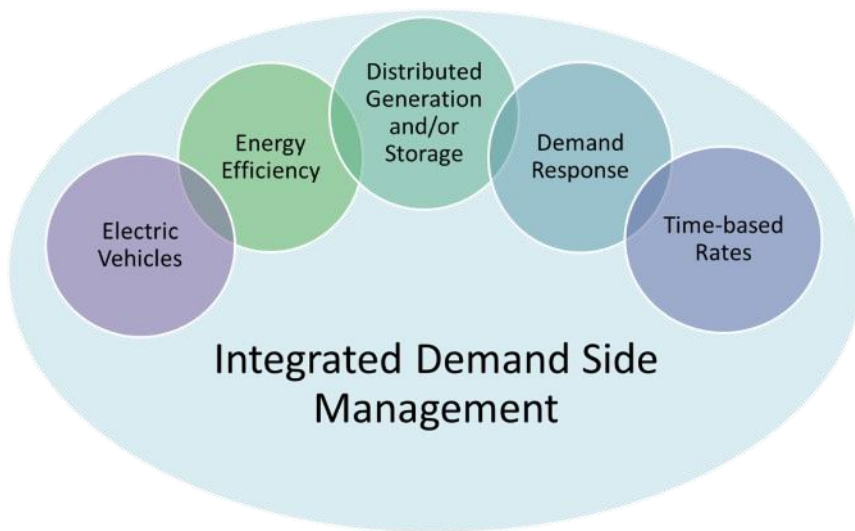


Figure 1: Illustration of the Program Types Included in IDSM

Figure 1 provides an illustration of the DSM components and the relationship within the umbrella of IDSM. As our definition indicates, three of the five DSM components must be offered as an integrated solution in order to qualify as IDSM. A utility can offer several IDSM programs and portfolios that include three or more DSM components, and a customer can select various measures from the

¹² For the purpose of this study, we refer to “smart” thermostats and communicating thermostats as programmable communicating thermostats. However, there are subtle distinctions between smart and communicating thermostats. Although both smart and communicating thermostats are two-way communicating and both may have accompanying web portals and mobile apps that provide insight into a user’s energy consumption and tips for increasing energy efficiency and reducing monthly bills, smart thermostats have added algorithms that enhance heating and cooling performance by data gathering and analytics that optimize HVAC settings for efficient and automated energy consumption (Silverstein, 2016).

¹³ An open and interoperable information exchange model and communication standard. OpenADR standardizes the message format used for ADR controls, gateways, and energy management systems to enable standardized communication of price and DR signals between customer facilities and utilities, Independent System Operators (ISOs), or Energy Service Providers.

offerings. For this study, the discussion and definition of IDSM is limited to include electric utility program delivery and rates. Time-based rates are included in the definition of IDSM as they often augment or support the value of IDSM by sending price signals to devices or customers that have installed DSM technologies and measures.¹⁴ From the perspective taken in this report, IDSM can fit under the umbrella of NWA as it aims to address targeted distribution system constraints with DSM opportunities. The value proposition of NWA could be extended to IDSM programs and promote the rationale for pursuing integrated portfolios of measures. However, these competitive solicitations currently do not result in deploying customer-facing IDSM programs that followed the definition presented above, but rather procure any eligible DSM resource that meets a specific system need.

As suggested above, IDSM is a concept that is evolving as new integrated technologies and end-use measures become available for mass market adoption. As prices decrease for thermostats, ADR enabled end-uses (e.g., advanced lighting systems, home/building energy management systems and sensors), battery storage, and smart EV chargers, we can anticipate that market adoption of these technologies will increase. These market trends will help shape the development of future IDSM programs by program administrators.

IDSM initiatives were originally developed under the assumption that increased coordination across the entire range of DSM programs could reduce some program delivery inefficiencies and lead to customers maximizing their energy savings (Berg et al., 2017). Literature on the rationale for pursuing IDSM, as defined in this report, is very limited. Existing literature concerning the coordination of EE and DR provides insights into the potential value that IDSM could provide, including the following:

- The changing generation mix (e.g., increasing penetration of on-site solar PV) is creating demand for flexible energy management technologies that not only decrease baseline energy consumption (kWh), but also address optimizing energy consumption on a time-variant basis, e.g., reducing load in the evening through efficiency and demand response (Alstone et al., 2017). The deployment of IDSM technologies can help shape energy consumption and demand to match the grid's dynamic needs, rather than simply providing static electricity demand (kW) or annual electricity consumption (kWh) reductions. When deployed individually, DSM measures might deliver inadequate solutions for grid flexibility or local capacity needs, but the measures have characteristics that can provide complementary value when deployed in combination.¹⁵ When coordinated, IDSM programs may deliver more value as a whole solution than as individual components (SEPA and Nexant, 2016).¹⁶
- Goldman et al. (2010) suggest that increased coordination of EE and DR programs could be beneficial at both the provider and customer levels. There are significant differences between

¹⁴ For the purposes of Figure 1 we use time-based rates to represent a range of rates and pricing programs that can include time-of-use pricing, variable peak pricing, critical peak pricing and other location- or market price variable rates

¹⁵ Consider an example taken from Alstone et al. (2017): "... an HVAC load that has a 10 kW baseline and can be reduced by half of the service level (5 kW) with dispatchable control as supply DR. If the load is efficiency upgraded with one that uses 75 percent of the original energy load (i.e., an EE benefit of 25 percent), the baseline is now 7.5 kW for the same baseline level of service. If the service level is still reduced to half during a DR event, this means that there is only 3.75 kW available for supply DR (less than the original 5 kW Shed), but the overall effect of the combined EE and DR on the net load is a reduction of 6.25 kW—an increase in total DR compared to the original configuration that also comes with all the benefits of EE upgrades. If one only considers the availability of supply DR in the absence of the underlying load-modifying effects, however, an efficiency investment can appear to reduce the quantity of available demand response."

¹⁶ In one example of how planners are considering the contributions and value of energy efficiency, DR, and other resources, the Northwest Power and Conservation Council conducted stochastic modeling to consider the effects of different combinations of resources (NPCC, 2016).

EE and DR programs, including how they are funded, evaluated and delivered, and what organization delivers the programs. However, Goldman et al. suggests that for providers (e.g., utilities, third-party program administrators and program implementers), coordination within or across departments or organizations could result in program delivery cost savings and thus increased cost-effectiveness. Customers may be more receptive to a more seamlessly integrated program marketing and delivery experience, than they are to the current fragmented approach. Increased customer willingness to engage with integrated programs could lead to greater energy savings than might otherwise have been achievable.

- Energy efficiency upgrades can improve facility operations and provide a foundation for the deployment of demand response strategies. OpenADR strategies can be implemented as an enhancement to upgraded equipment and facility control strategies installed as energy efficiency measures. Conversely, installation of controls to support OpenADR may result in improved energy efficiency through near real-time access to energy consumption load data (Han and Piette, 2008).
- York and Kushler (2014) identified several potential benefits, based on their own literature review, related to the synergies between EE and DR.
 - The authors found that the kinds of communication, metering and control technologies incentivized by EE and DR programs increased customers' ability to control their building systems both for DR events and for year-round and seasonal energy management.
 - There was also evidence that the technologies installed led participants to identify and take further energy efficiency actions. When the customers received information on their energy usage and costs from the energy management control systems, they implemented additional energy efficiency measures (e.g., installed efficient lighting and HVAC equipment).
- Leuschner et al. (2016) suggest that several technical, policy and economic factors provide motivation for utilities to pursue IDSM including the following: 1) increasing DSM goals will increase pressure to obtain more EE savings per program; 2) potential for IDSM to reduce program costs through eliminating duplication and better engage customers; and 3) enabling better targeting of DSM efforts to address locational load or infrastructure constraint issues.

To date, the electric industry has very limited experience with IDSM. States use different terminology when referring to integrated delivery of demand-side resources. California is the only state that has explicitly labeled a program as IDSM.¹⁷ The Northeast Energy Efficiency Partnership (NEEP) has also adopted the term IDSM in working to encourage utilities to integrate at least EE and DR marketing and technology deployment (NEEP, 2016). Evolving activities and efforts of utilities and program administrators in states pursuing the concept of IDSM tend to focus at present on coordinating programs that cut across two types of DSM technologies, namely EE and DR. For example, a number of utilities (e.g., Austin Energy, Commonwealth Edison, Georgia Power and Xcel Energy) run programs which offer rebates on Wi-Fi connected PCTs that can be enabled to receive a DR signal during an event while providing the customer with longer-term efficiency savings via advanced controls and sensors that offer space conditioning with limited human interaction.

¹⁷ Discussion of "IDSM" was underway in California by 2005; in 2009, the CPUC established the IOUs' first statewide IDSM program for the 2010-2012 program cycle (CPUC, 2009). However, in 2014 the CPUC revised their IDSM proceeding and changed the name to integrated distributed energy resources (IDER).

The electric industry's limited experience deploying IDSM to date suggests that barriers may exist which stymie efforts to capture these benefits and pursue more integrated DSM activities.¹⁸ This scoping study explores recent utility industry experience with IDSM to provide an updated assessment of any benefits and barriers perceived or experienced by program administrators in their attempts to implement IDSM programs. As such, the experiences of those who have not yet delivered programs that fully meet our definition of IDSM still have relevance for this scoping study. Specifically, this scoping study seeks to:

- Highlight examples of programmatic mechanisms that have been or could be deployed for delivering IDSM technologies;
- Identify the benefits reported by program administrators that IDSM has provided or may provide to the bulk power and distribution system;
- Identify a prioritized set of barriers that has been or could be experienced by program administrators to more fully implement IDSM; and
- Discuss efforts that have been or could be undertaken to overcome these barriers.

This report is intended to inform electric utility regulators and policymakers, utility program administrators and other stakeholders involved in utility DSM program and portfolio planning and DER acquisition activities. This scoping study presents information collected from a sample of electric utilities that are currently administering IDSM or plan to administer IDSM programs in the near future.

This report is structured as follows: In the next section, we describe our research approach and data sources. Chapter 3 provides a utility program taxonomy and a description of current DSM and IDSM program delivery approaches. Chapter 4 presents our findings on program administrators' assessment of the current motivations for and benefits from IDSM portfolios. In Chapter 5 we discuss respondents' assessment of the market and policy barriers for implementing IDSM and the challenges for measuring success. In Chapter 6, we discuss opportunities identified by our sample of program administrators for overcoming barriers and provide lessons learned in IDSM implementation from their implementation experience. In Chapter 7, we present what program administrators believe are the opportunities for accelerating IDSM implementation. Chapter 8 provides a discussion of ideal future IDSM portfolios, while Chapter 9 concludes the report with some closing thoughts.

¹⁸ In California, under the 2010 IDSM proceeding, the IOUs were instructed to develop programs and performance metrics for IDSM program portfolios. The IOUs struggled to develop cost effectiveness metrics that could accurately reflect the value to the ratepayers and to reorganize program operations to carry out the IDSM programs. Over several years, the programs were abandoned. In 2014, the CPUC opened a new proceeding for IDER R.14-10-003 and issued a decision (CPUC, 2016) which approved a competitive solicitation framework and a utility regulatory incentive mechanism pilot.

2. Methodology and Approach

To better understand the current status of IDSM efforts in the electric industry, we sought to gather input directly from utilities and/or program administrators. Our primary data collection method was a survey instrument, with follow-up interviews of each respondent. We reached out to 10 utility and third-party program administrators that had implemented, were currently implementing, or intended to implement IDSM programs, to ask if they would participate and provide information for our study. Eleven staff from eight of the utility and third-party program administrators responded and participated in the data gathering exercise used to inform this study, as shown below in Table 1.¹⁹ Therefore it is important to note that the focus is on electric utility IDSM efforts from interviews conducted with a small sample of utilities and one program implementer, which narrowly focuses the viewpoints represented herein. We sent questionnaires and worksheets to the participating program administrators to obtain program information on ongoing and future IDSM activities. The questionnaire also sought opinions as to barriers, challenges, and opportunities for IDSM in the near term and looking forward 10 years. The data collected included ranked questions, open-ended questions, and “Yes” or “No” options for various statements on IDSM. A copy of the data collection tool is included as Appendix A.

Table 1. Participating Organizations

Avangrid
Consolidated Edison of New York
DTE Energy
Hawaiian Electric Company
Hawai'i Energy (Leidos)
Pacific Gas & Electric
Sacramento Municipal Utility District
Southern California Edison

For a few of the program administrators, more than one staff member responded to the information request, each reporting from a different department of their organization. Each response was recorded separately for analytical purposes. So, when interpreting the results, it is important to note that there may be two to three responses from a single program administrator. The respondents from different departments within the same program administrator often provided different responses from their counterparts.

¹⁹ We also conducted phone interviews with EnergySolutions, a program implementer, and three Energy Service Companies (ESCOs) (BlueRock Energy, Opterra and Siemens) to learn more about the state of IDSM from their position in the industry. The objective of the phone calls was to understand what actions these organizations were undertaking to expand their roles in delivering integrated demand side management solutions to customers. In addition, Southern California Gas (SoCal Gas), who delivers DSM that affects gas, electricity and water usage, completed our survey and was subsequently interviewed. Given that the focus of this paper is on the electric industry exclusively, we chose to exclude SoCal Gas when reporting results. However, the information they provided reinforced much of the information we received from the included program administrators.

3. The Current Landscape of DSM and ISDM

In this section, we provide a brief overview of the different DSM program types currently offered to electric utility customers. When coordinated and integrated, these programs would fall under the rubric of ISDM program delivery. These can apply to utility-administered or third-party administrator programs for the residential, commercial, and industrial customer sectors that may be funded by ratepayer charges, through public benefits funds, rate cases or other means.

3.1 Current DSM Program Offerings

The current portfolio of DSM program offerings can be organized around the technologies and grid services those technologies provide to the utility.

- **Energy Efficiency (EE):** programs that incentivize deployment of EE technologies and behaviors. These can include upstream, midstream, or downstream²⁰ rebates/incentives for equipment (e.g., HVAC, lighting, appliances, and other measures²¹) and other energy efficiency programs such as custom rebates, behavior based programs, retro-commissioning and new construction. Utilities often market EE rebates through appliance retailers and more recently, have set up online marketplaces that make recommendations for efficient consumer products like appliances, light bulbs, and smart power strips.²² Furthermore, utilities partner with trade allies (e.g., architects, engineers, certified contractors) that perform weatherization upgrades or conduct audits and make efficiency improvements to customers' homes or businesses. EE program activities also include education and awareness campaigns to end-users and trade allies.
- **Demand Response (DR):** a mechanism through which an end-use's load profile is changed (by the user, a third party, or a utility) in response to system needs, often in return for economic compensation (e.g., payments or a different rate structure) (Potter and Cappers, 2017). For example, programs that utilize control technologies, such as smart thermostats, direct load control switches, plug load controls, or automated demand response (ADR) technologies, and/or behavior based DR programs. The majority of DR programs offered target heating and cooling measures, however, several utilities offer custom rebates to commercial customers that install other measures that are enabled with Automated Demand Response (ADR) and agree to participate in DR programs. Offerings can also include behavior-based programs.
- **Distributed Generation (DG):** programs that offer rebates, incentives, and grants to utility customers that install DG technologies on site, such as photovoltaic (PV) solar, fuel cells, combined heat and power (CHP), and small wind turbines.
- **Electric Vehicle (EV):** programs that provide incentives or rebates for deployment of EVs, EV chargers, grid-integrated EV smart chargers or offer special time-based rates (TBR) to

²⁰ Upstream, midstream, and downstream EE incentive payments refer to the three categories of rebate participants. Upstream refers to incentive payments made to manufacturers for manufacturing specific models that meet high efficiency standards. Midstream refers to incentives paid to retailers that carry and co-brand (with the program administrator) the highest EE tier rating end-uses. Downstream incentives are paid to the customer, often as a rebate after the purchase of the qualifying equipment has been made.

²¹ A "measure" refers to any type of demand side management project (e.g. upgraded insulation), technology (e.g. programmable communicating thermostats or energy management control systems), appliance (e.g. HVAC or lighting upgrades), or other end-use (e.g. battery or vehicle charging unit) that once installed, can reduce and/or optimize energy consumption at a premise.

²² See for example Con Edison's Marketplace at <https://marketplace.coned.com/>

encourage specific charging behavior patterns that can minimize the load impact to the distribution system.

- **Storage (ST):** programs that incentivize customer deployment of storage technologies, such as Li-ion and other types of batteries, grid-integrated electric water heaters, commercial and residential thermal energy storage (TES), and, in some cases, grid-integrated EV smart chargers. Storage functions like a battery as it can be used to provide power to the customer or the grid during times of critical need and can absorb power from the grid when prices are lower, providing market arbitrage. Some storage technologies can also respond to price signals. Storage options range from voluntary behavioral response by owners, to planned, event-based dispatch to meet critical grid needs. Notably, storage may also provide other high-value services to the grid similar to those that fast-responding DR systems can provide.
- **Time-Based Rates (TBR):** Electricity rates paid by customers in which rates vary for different days, times of the day, or events (such as days with extremely high loads). The electric utility alters the price level charged to retail customers for electric commodity purchases in order to elicit a change in electricity consumption. While TBRs are not universally considered DSM programs per se, many utilities consider TBR to be the cost-benefit foundation for DSM and IDSM program adoption. At present, there are four general types of time-based rates:
 - *Time of use pricing* (TOU) rates provide different but predetermined prices over specific time periods (e.g., summer weekdays between 4 PM and 9 PM).
 - *Critical peak pricing* (CPP) rates institute a single or variable predetermined price for electricity during a narrowly defined period (e.g., summer weekday between 4 PM and 7 PM) that is only applied during specific system operating or market conditions and generally limited in the number of times it can be dispatched (e.g. twelve times per year).
 - *Variable peak pricing* (VPP) rates provide different prices over specific time periods (e.g., summer weekdays between 4 PM and 9 PM) that vary daily based on system operating and/or market conditions. Often times the dispatch of the highest priced level is limited, as is the case with CPP.
 - *Real-time pricing* (RTP) applies a rate schedule where the price can differ by hour of the day. There are two common forms of RTP: one that provides the twenty-four-hour price schedule a day in advance (DA-RTP) and another that provides the hourly price within 60 minutes after consumption has already occurred (RT-RTP).

3.2 Current IDSM Program Offerings

Conceptually, in an integrated DSM program, a customer is offered (either simultaneously or in coordination) the marketing materials, rebates and incentives, and/or financing for a comprehensive menu of measures that provide multiple benefits and can be installed as a single package, or as interconnected portfolio of measures. An example of a multi-attribute IDSM end-use technology is a grid-integrated water heater that can offer energy efficiency savings, thermal storage, and provide demand response resource when a signal is dispatched. A customer could be offered a home area gateway that connects to a portfolio of available efficient end-uses in the home that can provide DR services in response to a price signal also illustrates an integrated approach. Integrated DSM goes one step deeper than DSM to the extent that it aims to optimize behind the meter usage with three or more types of DSM program measures, behaviors, or savings impacts.

At present, there are very few true IDSM programs in operation in the United States electric industry that fit within the definition presented in this paper.²³ In California, SMUD is implementing IDSM programs for new residential construction called “Smart Homes”²⁴. The programs include a portfolio of EE, DR, and DG measures, along with advanced EV chargers or storage incentives. These new construction programs incentivize and partner with contractors to build highly efficient and interconnected homes and advertise the homes or buildings as “next generation” models with advanced technologies.

A number of program implementers are moving towards IDSM by coordinating certain elements of their existing DSM programs (mainly EE and DR) and TBR offerings in the hopes they can expand into other DSM technologies down the road. For example, many program administrators offer financial incentives for Wi-Fi connected programmable communicating thermostats that can be enabled to receive a DR signal during an event, provide the customer with long-term efficiency savings, and automatically respond to time-based rates via automated controls and sensors.²⁵ As another example, pursuant to the CPUC DR program budget (part of the statewide energy efficiency DSM budget) for 2018-2022 (CPUC, 2017a), SCE and PG&E are considering programs that offer incentives for new building HVAC automation or lighting controls in order to ensure that the end-use systems support OpenADR, and that customers can respond to some form of TBR. This type of combined offering will make it less costly for the customer to join a DR program in the future (Alstone et al., 2017) by eliminating the need to subsequently buy new enabling DR equipment. Such programs create a “future-proofed” DR-enabling technology platform when implementing EE project investments.

²³ Per the definition agreed-upon by nearly all of the respondents, for the purposes of this paper the definition of IDSM involves three or more of the different program types. Few efforts today meet that definition.

²⁴ See <https://www.smud.org/en/Going-Green/Smart-Homes>

²⁵ For example, see: <https://pages.email.sce.com/SCESmartBonus/>; <https://www.comed.com/WaysToSave/ForYourHome/Pages/SmartThermostatRebates.aspx>; and <https://www.sdge.com/business/programmable-communicating-thermostats>

4. Motivations and Benefits of those Currently Pursuing IDSM

In this section, we summarize the views of our sample of program administrators on their internal motivations and perceived benefits of implementing IDSM.

4.1 Program Administrator Motivations and Benefits

We presented survey participants with a list of potential business drivers for IDSM and asked the respondents to select all answers that apply to their organization. The more respondents who selected a particular answer suggests that it is a more widely applicable business driver across the various program administrators than answers that were only selected by a small subset of respondents. For example, over 90% of the respondents indicated that the IDSM portfolio benefits include: 1) compliance with regulatory mandates to offer IDSM portfolios; and 2) the ability to increase the number of DSM measures that are capable of optimizing customers’ end-use consumption (see Figure 2). Over 80% of the respondents agreed that reducing the market confusion that customers might experience about different demand side program offerings is a key motivator for implementing IDSM. Approximately two-thirds of the respondents indicated that IDSM can improve the cost-effectiveness of program delivery, while ~75% stated that IDSM can increase customer engagement and satisfaction. In contrast, less than half of the respondents were motivated by IDSM’s ability to better meet locational and/or temporal grid needs. Only one indicated that IDSM was pursued to reduce duplication in their EE and DR programmatic offerings.

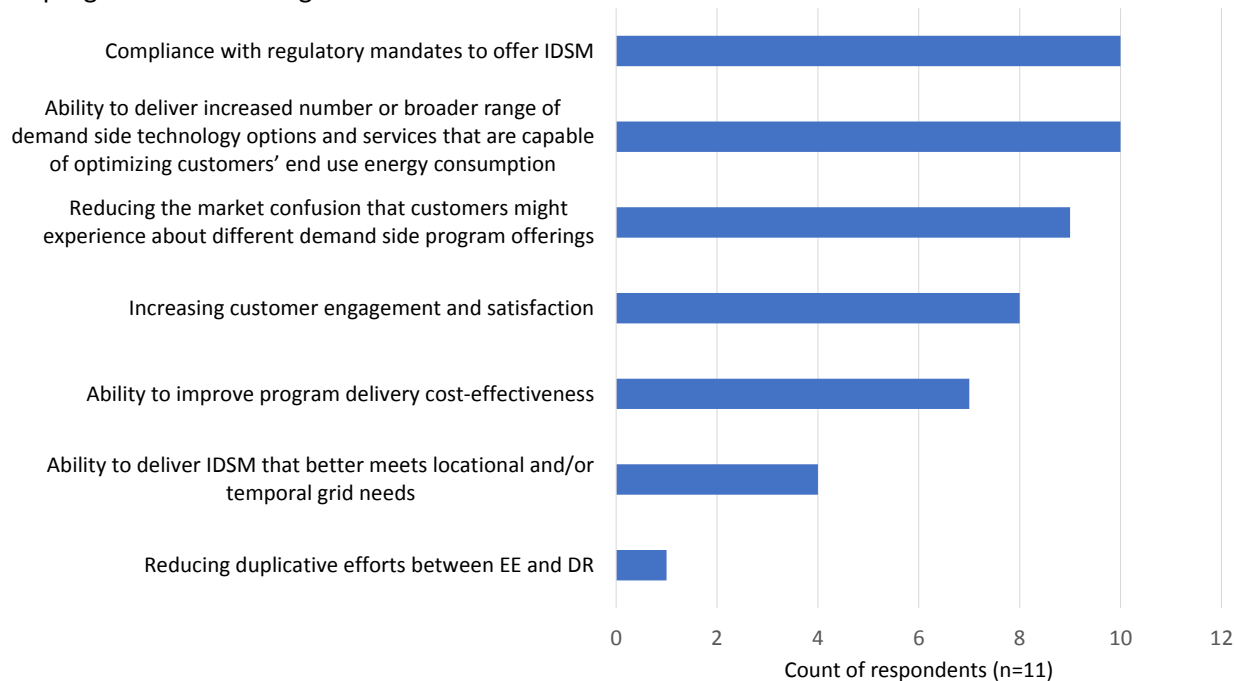


Figure 2: Program Administrator Motivations for Implementing IDSM Programs

Follow-on interviews with respondents further clarified these business drivers. We repeatedly heard that IDSM portfolios can help balance different program design objectives, such as delivering the right type of DSM so it benefits system needs while giving the customers more choice and control. This balance needs to enable the program administrators to meet regulatory mandates for EE, DR, and DG, all of which have different installed capacity goals, demand, and energy reduction targets. Many

“The primary driver for IDSM is to increase EE savings. The regulatory mandates for EE in California are very aggressive and while the goals are increasing, the EE potential is decreasing. IDSM programs offer an opportunity to get more efficient measures in the field, alongside other program measures, such as TBR and EV chargers. Our utility wants to deploy multiple measures across multiple trades (e.g. HVAC, lighting controls, building envelope, and EV chargers) into customer premises to maximize savings.” - Sacramento Municipal Utility District

respondents also stated that IDSM portfolios give them the ability to balance the numerous objectives within their organization since they have a more holistic approach to DSM delivery than with a single program.

We also asked program administrators to identify the benefits and outcomes that they are currently capturing or are showing potential to capture from their IDSM efforts. No single benefit was

identified by a majority of respondents, although half of the respondents believed that IDSM enabled more customers to participate in DSM programs and generated peak demand reductions that exceeded what DR programs alone could deliver (see Figure 3). Four of 11 respondents indicated IDSM had the potential to be more effective at addressing locational and/or temporal grid needs and improved cost-effective delivery of the included DSM measures. Three respondents also felt that their IDSM programs delivered greater savings than what stand-alone EE programs could do. Only one stated that IDSM programs are assisting with increasing the amount of renewable generation interconnected on the grid.

These results suggest that the respondents were less unified in their assessment of what benefits had been or were likely to be achieved. Since the survey instrument allowed respondents to “Check all that apply,” this finding suggests that the program administrators in our sample are

“Historical approaches to DSM limit the opportunities to offer holistic solutions to customers by concentrating solely on the end objective of Energy Efficiency, Demand Response or others. IDSM allows the opportunity to leverage existing customer touch points, such as an EE audit, to enable more meaningful custom program offering and solutions without burdening one portfolio’s cost-effectiveness for the sake of another resource.” - Southern California Edison

universally struggling to achieve the benefits that motivated them and/or regulators to pursue IDSM. For example, eight respondents indicated that they were motivated by the opportunity to improve program delivery cost-effectiveness, but only five stated that benefit had actually materialized or showed potential to materialize (see Figure 3). Nine respondents expected IDSM would increase customer engagement but only six believed their efforts had resulted or was likely to result in increased customer participation in DSM programs.

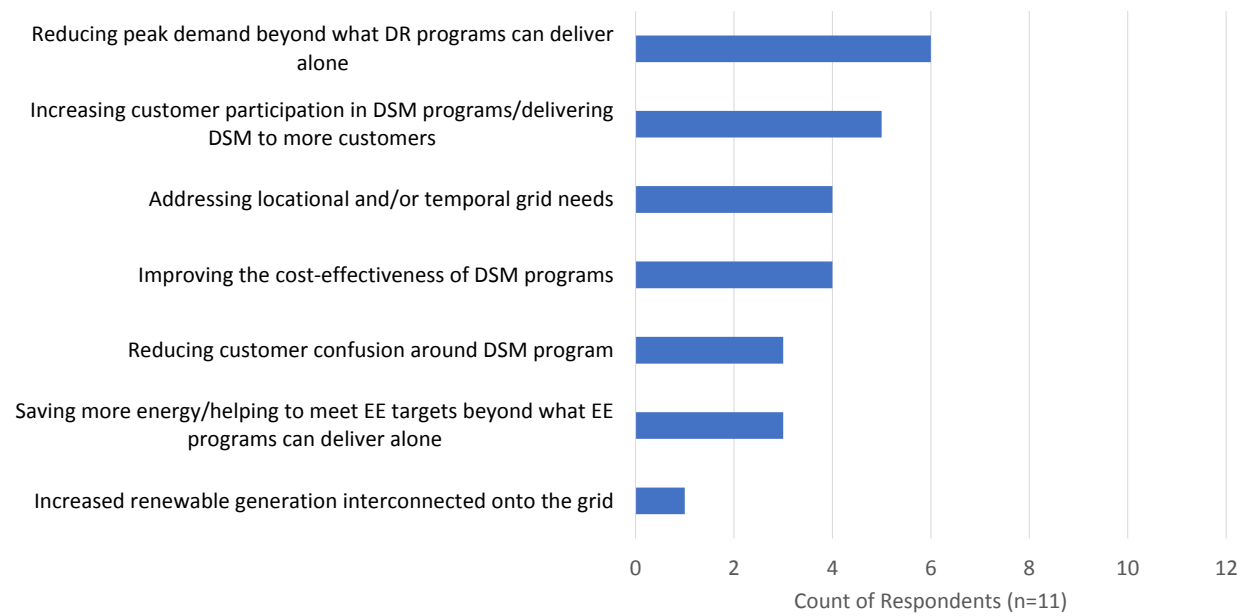


Figure 3: Benefits of IDSM that are Materializing or Showing Potential to Materialize

5. Market and Policy Barriers to Implementation of IDSM

The limited experience and success in the U.S. with IDSM program deployment to date, as discussed in Section 3.2 suggests a number of barriers likely exist that are stymieing such efforts. Goldman et al. (2010) suggested that market and regulatory structures, rate structures, customer perception and staff and contractor capabilities could present challenges to program administrators' ability to coordinate delivery of two types of DSM: EE and DR. Researchers and program evaluators have identified a number of potential and observed barriers to broader deployment of IDSM, including the following:

- **Division of Program Funding.** In most states, specific DSM programs are funded separately, via separate regulatory proceedings. For example, nearly all states with public benefit funds restrict those funds to EE, and in some cases, renewable energy programs as well (Holt, 2016). This presents challenges trying to administer integrated programs since, for example, administrative staff resources that support more than one type of program need to have their costs allocated to the different funding sources, which can be cumbersome for the organization to manage (CEC, 2015).
- **Division of Program Administration.** In a number of states, responsibility for administering different aspects of DSM is divided. For example, in some states, energy efficiency programs are administered by a state agency (e.g., Maine and New York) or a 3rd party energy efficiency administrator (e.g., Hawaii, Oregon, New Jersey) while the utility or ISO administers the demand response programs. Government agencies in these same states offer tax incentives for the purchase of EVs, but none of their utilities offer EV charging rebate programs yet. Integration or coordination across organizations, who might have competing goals and incentives, presents challenges and could require increased oversight by utility regulators (Goldman et al., 2010).
- **Misalignment of Program Cycles.** DSM programs generally require regulatory oversight for prudence that results in authorization for cost recovery of program administration expenses. Regulatory reviews cover a specific program period either in retrospect or anticipation of the program administrator's efforts. However, the timing for the specific program cycles for DSM programs (e.g., EE, DR, DG, and storage) are not necessarily aligned. This can result in an IDSM customer project, seeking to integrate a number of different technology solutions, having to submit multiple applications to different program administrators each subject to different review times. If the funding cycle for the various project elements are not aligned, decisions for the project may be required at different stages, preventing customers from completing integrated projects (FERC, 2016).
- **Inconsistent Cost-effectiveness Calculation Methods.** States frequently conduct individual proceedings to determine cost-effectiveness for the various DSM areas regulators are responsible for (e.g., EE, DR, DG, and storage). Rarely are the cost-effectiveness proceedings coordinated or similar in methodologies, resulting in the application of different cost-effectiveness tests. The different program types typically use different methods to develop base assumptions and inputs and thus concurrent and interactive benefits are not valued. Woychik et al. (2012) argue that a more consistent and complete approach to valuation and cost-effectiveness is critical for fully capturing the benefits of IDSM and smart grid deployment. The lack of consistency and accuracy in the methods, assumptions, and inputs across the various DSM resource types presents a significant challenge for creating an integrated cost-effectiveness framework.
- **DSM Technologies as Competitors not Complements.** Goldman et al. (2010) found that many facility energy managers were resistant to participating in DR and instead favored EE

as more of a “sure bet,” thereby reducing the potential to optimize their IDSM opportunities. The managers were uncertain that demand response could be executed consistently, and they had a perception that the modest DR payoff was not worth the effort to participate. The future cash flow from EE operational savings is often a more compelling financial driver for capital investment for EE technologies, while DR savings are event driven and episodic (Alstone et al., 2017).

5.1 Barriers Due to Regulatory Actions

Respondents were asked to indicate a specific level of significance associated with a list of regulatory barriers found in the literature (discussed above) to offering or expanding IDSM programs and portfolios. A majority of the respondents identified the separation of existing DSM program budgets as the most significant barrier to the successful implementation of IDSM (see Figure 4). A lack of effective metrics for evaluating cost-effectiveness was seen by more than half of the respondents as being a very significant or the most significant barrier. Five of the 11 respondents felt that a lack of integrated EM&V rules were also very or the most significant barriers. In the following sections, we discuss the respondents’ experiences for each of the identified regulatory barriers in more detail.

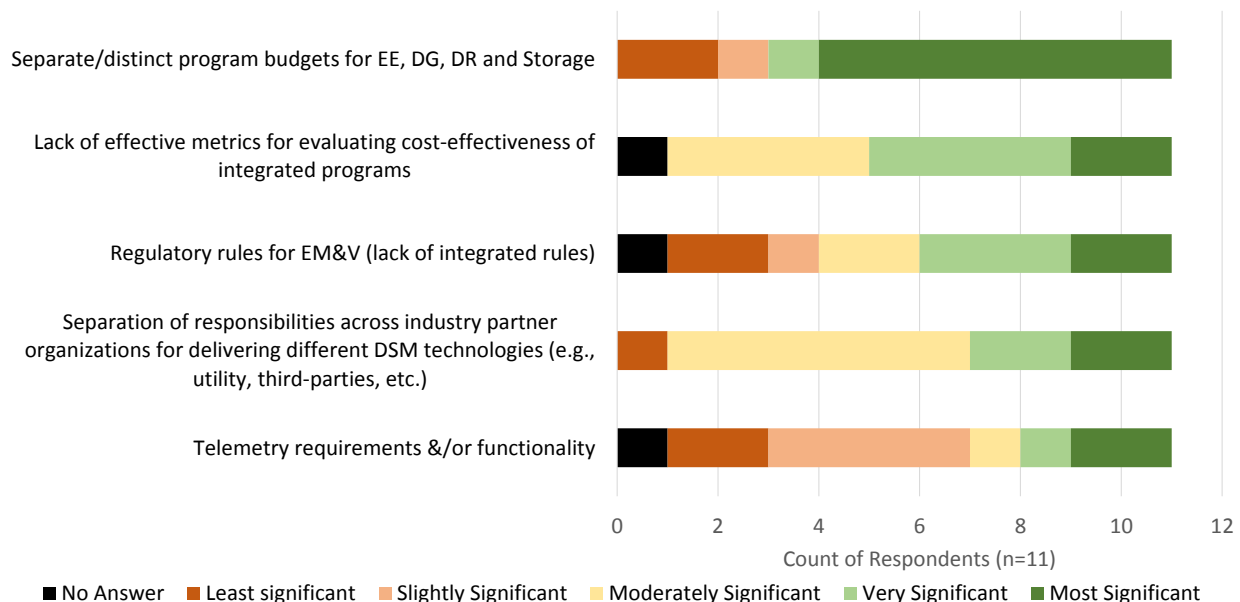


Figure 4: Ranking of the Regulatory Barriers to Implementing IDSM

5.1.1 Separate/Distinct Program Budgets

The respondents told us that separate and distinct program budgets created a number of challenges for their IDSM activities. A persistent barrier was the constant struggle between timing and funding cycles. When regulatory funding cycles for each DSM program budget are not aligned, (e.g. three-year cycles that do not coincide), funding IDSM projects can become problematic. For example, a customer may decide to integrate three different types of DSM technologies into one project (e.g., EE, DR and DG) that fall under separate regulatory proceedings and are subject to different timetables and sources of funding. The potential project may be voided if one DSM program budget cycle ends or funds are

depleted during a given year before the project is completed, while the other DSM programs continue to have adequate funds.²⁶

Many states have established separate funding sources and program budgets for the different DSM resources. For example, energy efficiency programs are funded through a variety of mechanisms including system benefits charges (SBCs), energy efficiency resource standards, and retail rates, if the utility is the program administrator (EPA, 2015). Alternatively, DR programs are generally paid for by utility ratepayers via their retail rates or some surcharge. In many states, there are constraints placed on how public benefits funds can be used and often prohibit the application of these funds for other DSM programs (Goldman et al., 2010).

“Utilities need to be enabled [within a regulatory framework] to look holistically at the impacts of a technology within the context of the utility and grid needs, not within a program. Integrating all aspects of IDSM into planning can better quantify benefits to utility operations.” - DTE Energy

For example, in California, utilities must seek approval for energy efficiency and demand response programs in separate regulatory proceedings and often on different funding cycles, complicating the integration of program funds for IDSM projects. Furthermore, as illustrated in the recent CPUC 2017 staff proposal on IDSM activities, various regulatory decisions often prohibit and or restrict the use of funds from EE and DR budgets, complicating the establishment of dedicated IDSM program budgets:

“Pursuant to D.12-11-015, IDSM-related activities are funded through a combination of EE and DR funds authorized in the EE application proceedings. DR funds make up the bulk of the IDSM budgets (See Table below). The EE IDSM program is a non –resource program, meaning it provides supporting activities such as research, tools, and coordination process. However, pursuant to D.12-05-015, the IDSM program does not provide funding for incentives to promote integrated projects. D.12-11-015 placed some restrictions on how IDSM funding could be used, namely that funds should not be used to pay for incentives. Thus, staff recommends the Commission relax this restriction to enable these funds (which will mostly be DR funds) to pay for incentives to cover the incremental cost of DR-enabling platforms or controls.” (CPUC, 2017b)

Furthermore, our respondents stated that DSM program managers within their organization are unlikely to integrate funding with other departments if there is not a clear benefit for their program portfolio. If there is not an established cost-effectiveness metric for an IDSM measure or a performance metric that can be attributed to their programs portfolio performance, there is little incentive for them to share program funds with other departments for IDSM initiatives.

5.1.2 Lack of Effective Metrics for Evaluating Integrated Programs

The majority of respondents agreed that conducting evaluation, measurement and verification (EM&V) and/or determining the success of IDSM programs is challenging given that there are multiple programs and measures interacting with each other. One of the challenges of estimating IDSM’s success or impact in a framework that is useful for planning and policy development is the manner that the programs differ from one another, with regard to metrics for measure lifetimes, capacity, energy savings, and durability.

²⁶ It is also important to note that DERs can be procured by utilities outside of traditional EE and DR programs, e.g., through rate structures, ISO markets, and targeted procurements to replace retiring power generation plants or defer distribution system investments.

For example, EE measures can erode the DR kW savings for some end-uses, and there has been a great deal of discourse about how to appropriately attribute value when this is the case (Woychik and Martinez, 2012). To date, no common approach to valuation or cost-effectiveness has been adopted for programs that cross disciplines; instead methods developed for each particular DSM technology or

“Another barrier to implementation of IDSM could be that the concept of IDSM is not well-enough understood by all parties, further complicated by the fact that the metrics used to measure the effectiveness of the EE programs does not provide sufficient incentive to implement IDSM. A reduction in energy consumption (kWh) is the simple metric for EE effectiveness, while the complexities of the grid system in Hawaii dictate a need for more dynamic metrics.” – Hawaiian Electric Company

program are generally applied.²⁷

According to respondents, this situation presents significant challenges for them to develop IDSM programs and projects. One program administrator suggested that IDSM programs might need to be evaluated on a case by case basis in order to determine the cost-effectiveness and value. As shown in Figure 4, another

common theme we heard from the respondents is that the lack of cost-effectiveness metrics, or EM&V metrics, negatively impacts their ability to deliver IDSM programs. Most of the respondents stated that developing a common framework for valuing and evaluating IDSM portfolios has proven to be insufficient when compared to implementing the measures under separate programs. Developing a common framework may present its own difficulties. Attempts to integrate different DSM technologies under a single DSM program budget can be challenging if different program objectives do not align with the cost effectiveness or valuation methodology employed. For example, a DR measure would likely not qualify under screening criteria for inclusion in an EE program portfolio.²⁸

Approximately half of the program administrators we surveyed indicated that they evaluate the performance of their IDSM portfolios. Those that do typically evaluate them under each DSM program umbrella’s performance metrics separately. So while the program measures are delivered as an integrated portfolio, the utilities are measuring the performance of the measures independently. The respondents indicated that no current framework exists for examining the holistic benefits of IDSM, such as evaluating whether the combined impacts of an integrated solution of measures are greater than the sum of the parts, or to what extent integrated measures can provide value by providing

“Under current regulatory rules, projects are likely to focus or be cost-effective and justifiable under one metric of DSM and unlikely under two. For example, an EE/DR program would ideally reduce all consumption first and then implement DR, on the other hand EE projects could reduce DR benefits (less load to drop), which would impact the DR potential of the project. A successful project achieves both, if not more, but antiquated cost-effectiveness rules limit the ability to capture holistic benefits.” – Southern California Edison

²⁷ Proposed methodologies to evaluate and attribute benefits from integrated programs are emerging, though; see for example Feldman et al. (2017).

²⁸ For example, as discussed in Feldman et al. (2017), when measuring and evaluating efficiency programs, each efficiency measure has an assumed lifetime during which it provides a relatively predictable stream of energy benefits from fixed equipment under regular operation. DR products, however, involve a set of strategies and actions taken by customers, or automatically by devices, in response to a system event or signal. These events may occur frequently or rarely depending on dispatch rules of the program administrator. This temporal variance in DR provision of grid services makes the characteristics of the value DR provides, and what constitutes cost-effectiveness, vastly different from that of energy efficiency. There are also differences in the durability of resources from year to year. Energy efficiency load reductions last for the full useful lifetime of equipment, while customer commitments to load curtailment are often renewed on a periodic basis (e.g., annually).

locational or temporal energy benefits to the grid. SMUD specifically stated that a common framework for the valuation of IDSM will be important, if not necessary, when more complex IDSM programs and projects.

Many of the benefits of IDSM programs can be temporal and locational, relieving some of the distribution constraints by using targeting to deliver IDSM projects to specific regions on the grid and using automation to control end-uses during specific hours of the day. Our sample of program administrators indicated that one of the main drivers for IDSM is to address grid needs and alluded to providing relief to distribution constraints caused by such things as increased penetration of distributed resources and aging infrastructure, both of which have locational and temporal characteristics.

Furthermore, approximately half of the respondents indicated that the current outcome metrics, such as kWh savings or kW reductions, fall short in measuring IDSM program performance. Only one respondent reported that the outcome metrics met their needs for measuring performance. Nine of the 11 program administrators are interested in helping to reshape EE program metrics, focusing more on load flexibility benefits and less explicitly on kWh reductions. In reviewing the answers from the respondents, it seems clear that they view IDSM program planning and portfolio deployment as an opportunity to re-evaluate and recreate EM&V metrics that better match grid needs.

5.1.3 Separation of Program Delivery Responsibility

State laws or utility commission mandates that require an entity separate from the utility to administer energy efficiency programs may create challenges for coordination and integration of DSM programs. For example, currently in Hawaii, Oregon, Vermont, Wisconsin and Delaware, the DR programs are administered by the electric utility, while a third-party contracted by the state or Commission (i.e. PUC or PSC) is responsible for the administration of the EE programs. Each is responsible for delivering a certain amount of DSM based on finite budgets. Program managers within each organization are usually evaluated internally by their ability to meet their specific programmatic goals. It is important for these different organizations and their associated managers to perceive value in coordinating their efforts to more cost-effectively deliver DSM. If regulators perceive a need for increased coordination across DSM strategies, they may direct administrators to report on their efforts to improve coordination.

“Currently in Hawaii the DR programs are administered by the electric utility, while a third-party contracted by the Hawaii Public Utilities Commission is responsible for the administration of the EE programs. As a result, the two entities have needed to work towards more coordination between DR and EE programs.” - Hawaiian Electric Company

5.1.4 Telemetry Requirements and/or Functionality

Several respondents indicated that the telemetry requirements and/or functionality was a moderate to significant barrier, while two indicated that it was a barrier to the highest extent. Telemetry barriers can be present in a number of ways; perhaps the most fundamental is a lack of advanced meters. An advanced meter that is commonly deployed with advanced metering infrastructure (AMI) has the capability of recording interval data from a premise at a variety of time intervals. The ability to provide near real-time data and price signals to customers has been foundational for those administrators that manage smart thermostat programs and other advanced demand response programs where two-way communication is needed. A number of utilities in the U.S. have not yet invested in advanced, digital meters. Lack of advanced metering can present significant challenges, if not make it impossible, to

perform the requisite granular measurement of customer loads that are participating in DR events or are on a TBR. For those utilities without advanced digital meters, IDSM programs may be cost prohibitive, and may be limited to only commercial and industrial customers where interval metering is ubiquitous.

In addition, centralized telemetry in the form of an electric meter may not fulfill future needs of IDSM programs when one considers the growing number of electric vehicles, battery storage, and distributed generation resources, which arguably could warrant their own separate metering telemetry in order to capture consumption and/or bi-directional energy flow. Furthermore, smart thermostats and smart appliances can collect and communicate end-use consumption data to the customer or to a third party, which already decentralizes the collection of energy consumption data from the utility electric meter. IDSM will require new methods of sensing, analyzing and operating electric distribution systems because of the growth and deployment of various consumer end-uses and devices that could ultimately decentralize energy measurement.

5.2 Barriers Due to Program Administrator Actions

Respondents were also asked to identify the significance of several barriers that might be within the program administrator’s purview to address. Overwhelmingly, the respondents believed that the single biggest barrier to offering or expanding IDSM activities was the separation of responsibilities within their organizations for delivering different DSM technologies; eight out of 11 rated it very or the most significant (see Figure 5). None of the other market barriers garnered more than a ranking of moderate from a majority of respondents. In the following sections, we discuss the respondents’ experiences with each of these program administrator barriers to offering or expanding IDSM programs and portfolios.

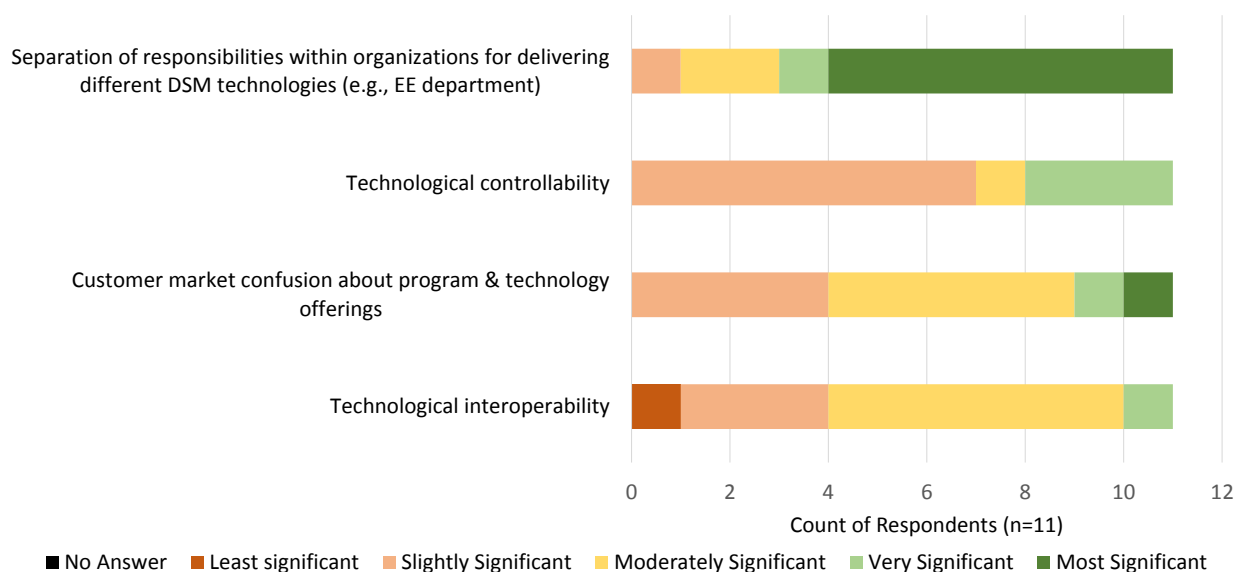


Figure 5: Ranking of the Program Administrator Barriers to Offering or Expanding IDSM

5.2.1 Separation of Responsibilities within Organizations for Delivering DSM Programs and Technologies

Demand side management programs are typically implemented and managed by business units organized around technologies, such as EV chargers, and there may be little coordination between program managers within the organization that would integrate the various DSM program silos. For the program administrators we

interviewed in this study, most typically have dedicated business units²⁹ that deliver DG, storage, EVs, EE and DR programs and technologies.

“Developing a common valuation framework is challenging. Also having rate structures that work across technologies is challenging, (e.g. EE/PV tradeoffs, DR/storage tradeoffs); it is hard to combine programs when there are different perspectives within the organization around value frameworks based on what the technologies can do.” - Sacramento Municipal Utility District

Each business unit is responsible for planning program activities, obtaining approval for the operational, incentive and rebates budget, marketing, education and outreach, and administering the programs. It is common within the industry to refer to these business units and departments as “program silos.” Each program silo works towards its specific program goals and maintains a distinct budget, separate from other programs with very little, if any, overlap or collaboration.

Program silos can present a challenge when they do not permit the collaborative marketing, administration, and pooling of resources that could otherwise enhance delivery of integrated DSM measures. In particular, regulated utilities as well as some third-party administrators have programmatic funding cycles that often differ for each DSM program which further exacerbates the separation and “siloeing” of program delivery.

5.2.2 Technological Controllability and Interoperability

Program administrators identified the challenges posed by interoperability and controllability in technologies and communications platforms of only modest concern. Most of our survey respondents ranked technological interoperability and controllability as at least moderate barriers. Program administrators that can leverage AMI and other grid modernization infrastructure investments, still often face significant technical hurdles integrating infrastructure and end-use technology elements. It is challenging to coordinate and control field devices, communication networks and management and control systems. The effort often requires integrating several different infrastructure systems to define an emerging technology capability, which involves addressing interoperability, standards, and processes. Data from several disparate systems may need to be integrated to run and evaluate a successful IDSM program.

5.2.3 Customer Market Confusion about Program and Technology Offerings

Nearly two-thirds of the respondents stated that customer confusion about program and technology offerings was a moderately significant barrier, while two reported that it was a very significant and the most significant barrier (see Figure 5). Respondents stated that various customers are at different stages of understanding the structure and process of the program administrator’s incentive opportunities for DSM measures. While marketing and education aims to inform customers about the range of DSM options available to them, often marketing and outreach materials focus solely on a

²⁹ A business unit can be defined as a relatively autonomous division of a company that operates as an independent enterprise with responsibility for a particular range of products or activities.

specific DSM program or measure. Program administrators typically have marketing schedules where they deliver materials for one DSM department every couple of months, cycling through each of the departments over the course of a year. If the marketing campaigns do not present offerings in combined or coordinated fashion (e.g., under a single program branded website, or using a consistent key marketing message for all DSM) customers are not likely to understand how different programs would be interrelated (e.g. smart thermostat program that incentivizes EE and DR).

In the case where a third party administrator is responsible for delivering one set of DSM programs, while the utility or another program administrator is responsible for other DSM programs, the customer confusion can be exacerbated. In Hawaii, Hawaiian Electric Company (HECO) is responsible for the DR and PV programs, while Hawai'i Energy, a third party administrator, is responsible for the EE programs. Both entities expressed that this division causes customer confusion; sometimes customers call HECO for EE rebate/incentive questions, and call Hawai'i Energy about DR. In this case, customers receiving DSM programs from different company brands leads to some confusion in the marketplace in the absence of coordinated marketing efforts.

As another example, PG&E has been working on an IDSM marketing campaign for about 5 years, aimed toward moving customers along the spectrum of initial understanding of DSM through to implementing integrated projects. At any given time, some customers are new to DSM, and others have had more exposure. The utility has focused on getting customers to understand the benefits from an IDSM approach. Depending on where the customer is on the continuum, the team provides them with material appropriate to the customer's level of knowledge and recommends actions customers are expected to be comfortable with. An integrated strategy encourages customers to see that some measures that might appear prohibitively expensive by themselves make sense in a larger project with other measures (FERC, 2016). Overcoming this knowledge gap with customers is a significant task, and overcoming market confusion continues to be an acknowledged challenge.

6. Actions Taken to Implement IDSM

In this section, we summarize respondents’ views on actions that they have or could take to reduce barriers to implementing IDSM.

6.1 Program Administrator Actions

Almost all of the respondents reported that they have undertaken one or more activities within their own organization to promote the expansion of IDSM, but only one action had been implemented by a majority of respondents – consolidation of intra-organizational responsibility for delivering certain DSM technologies (see Figure 6). Each of these particular activities are discussed in more detail below based on the respondents’ reported efforts.

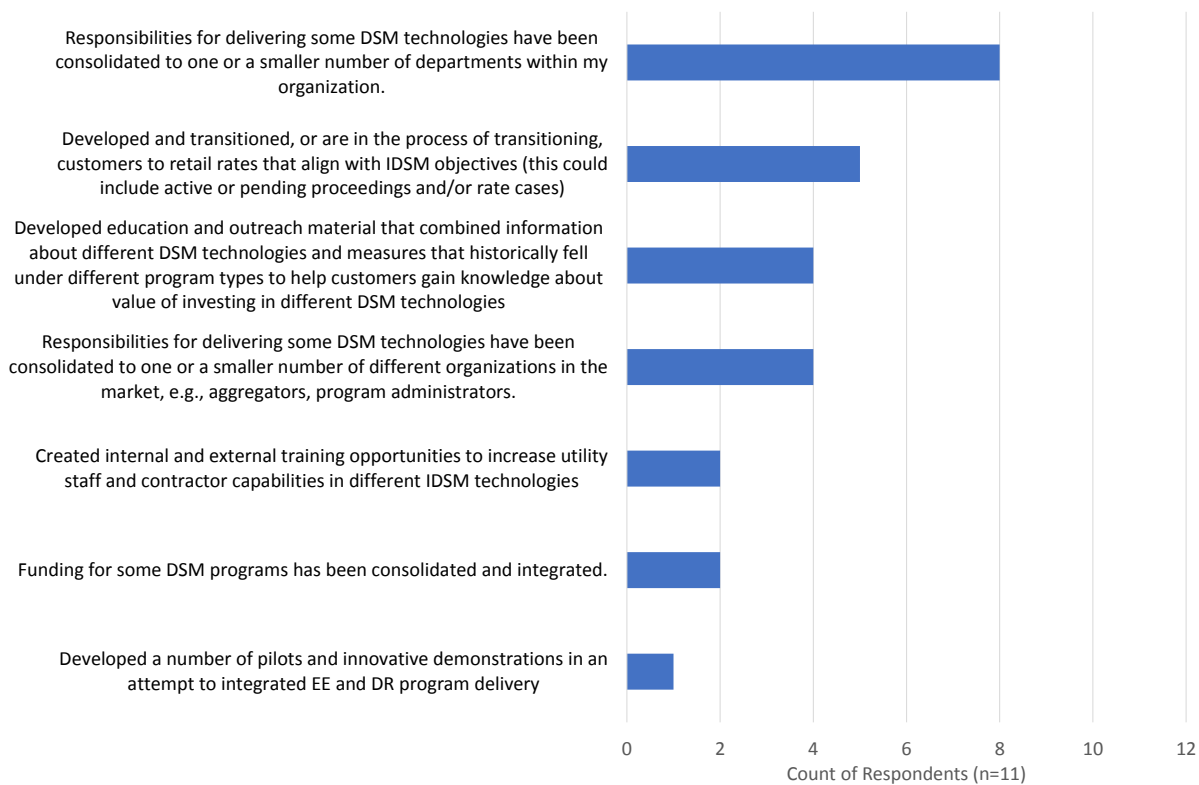


Figure 6: Activities Undertaken to Enable the Integration of DSM Delivery

6.1.1 Consolidate DSM Departments

The most commonly reported activity from our program administrator participants (eight out of 11) was that the responsibilities for delivering some DSM technologies have been consolidated to one or a smaller number of departments within their organization to enable implementation of IDSM programs. By building dedicated IDSM business units, program administrators can create a group of DSM experts that are well versed in all of their DSM offerings and can recommend integrated DSM measures to customers. As discussed in Section 5.2.1, some interviewees reported that there was limited coordination between program business units. For example, more than one program administrator told us that staff in one DSM unit were unaware of program offerings in other business units. These program silos can limit the knowledge transfer of customer DSM opportunities (and exacerbate

customer confusion, as discussed earlier in the paper) potentially missing out on opportunities to maximize the effectiveness of the DSM program portfolio. For those program administrators who integrated and consolidated DSM departments, the knowledge transfer facilitated program delivery and encouraged implementation of IDSM programs.

6.1.2 Time-based Retail Rates

Approximately half of the respondents reported that the utility is transitioning or hopes to transition customers onto TBR. Sending price signals that encourage a shift in consumption along with IDSM measures can contribute to efforts to accelerate IDSM. Several of the program administrators indicated that while TBRs are not necessarily considered programs, they can provide the basis for promoting the value of pursuing DSM programs. For example, SMUD explained that rates are a major customer motivator for battery storage, where demand pricing helps set the customer value proposition. Without carefully designed retail rates that support the various DSM resources, there may be little motivation for customers to adopt technologies when there is not a clear value stream. In the case of EV chargers, TBR can motivate certain charging behavior that coincides with distribution system needs. Retail rates can set the foundation for IDSM programs and provide value to customers that choose to adopt these technologies. With respect to solar PV, utilities are beginning to consider the need to pair storage with PV assets while exposing these customers to time-based rates or compensation programs.³⁰

6.1.3 Develop Integrated Marketing, Education, and Outreach Material

Four of the eleven respondents also reported developing marketing, education, and outreach (MEO) material that combines information about more than one DSM technology and/or measure that typically fell under separate program types. Integrated marketing provides combined or coordinated information on EE, DR, DG, EV, and storage programs, and can reduce the number of touchpoints or information channels that can cause customer confusion (as discussed in Section 5.2.3). Several respondents indicated that developing IDSM marketing collateral can be challenging because marketing efforts are funded largely through the separate DSM budgets (see Section 5.1.1). In some cases, each business unit wants their program to be featured in the marketing, rather than offering an integrated message across several programs. Despite these challenges, program administrators report making progress on integrating marketing material.

6.1.4 Develop and Implement Training Opportunities

Only two of the program administrators in our sample reported that they had created internal and external training opportunities to increase internal staff and contractor capabilities in different IDSM technologies. The audiences for these training sessions can include account representatives, third-party implementers, contractors, and DSM

"A collaboration framework was established between the utility and Leidos, who operates as the administrator for the Hawaii Energy programs under contract with the Hawaii PUC. The collaboration seeks to identify opportunities that enable both energy efficiency and controllability using the same end use or enabling technologies." - Hawaiian Electric Company

³⁰ In Fall 2017, the Hawaii Public Utilities Commission issued a decision that approved two new TBRs, (1) that aims to incentivize customers to install PV plus storage, and the other that credits customers for exporting energy to the grid during peak hours, but not during the mid-day hours (HPUC, 2017b). The TBR that encourages customers to adopt storage with PV is an excellent example of an IDSM program, inasmuch as it integrates three of the five DSM components.

program support staff. Typically, the intent is to educate staff on integrated approaches, tools and resources available to deliver integrated solutions for various customer segments. By extending training opportunities to program implementers, contractors, and government partners, program administrators that engage in training to promote IDSM can ensure that these external parties are aware of these IDSM programs and opportunities.

6.1.5 Funding for DSM is Consolidated and Integrated

Only two respondents reported that funding for some of the DSM programs has been consolidated and integrated, enabling the ability to offer integrated technologies and measures under one program budget. Divided program funding sources is one of the most cited barriers by our pool of program administrators to implementing IDSM (see Section 5.1.1).

6.1.6 Develop Pilots/Demonstration Projects

Efforts to transition at least some programs to an IDSM approach are still in the early development stages for most program administrators in our sample. While program administrators are developing new programs that include solar PV, storage, smart inverters, EVs, EE and DR, there has been few large-scale deployments of IDSM programs that incorporate three or more of the program types. However, our research found that many program administrators are conducting demonstration projects that test emerging technologies using integrated solutions. As an example, PG&E recently completed its Electric Vehicle Smart Charging Pilot, “BMW i ChargeForward,” which demonstrated advanced DR capability and delivery of grid services utilizing customers’ EVs and smart chargers and stationary BMW EV batteries (Kaluza et al., 2017). This demonstration project, like many others, may be laying the foundation for future IDSM programs by providing verification of customer end-use savings and grid impacts. However, only one Program Administrator respondent indicated that they were currently developing and deploying IDSM pilots.

7. Opportunities for Expanding IDSM Portfolios

The program administrators who responded to our survey provided their own assessment of how IDSM efforts could be expanded. In this section, we summarize those suggestions.

7.1 Program Administrator Opportunities

Program administrators identified three specific opportunities that they could pursue. Respondents selected their perceived level of importance of each for expanding their IDSM portfolio (see Figure 7) and then through interviews provided more insights into their own expectations, experiences and best practices that others might want to consider.

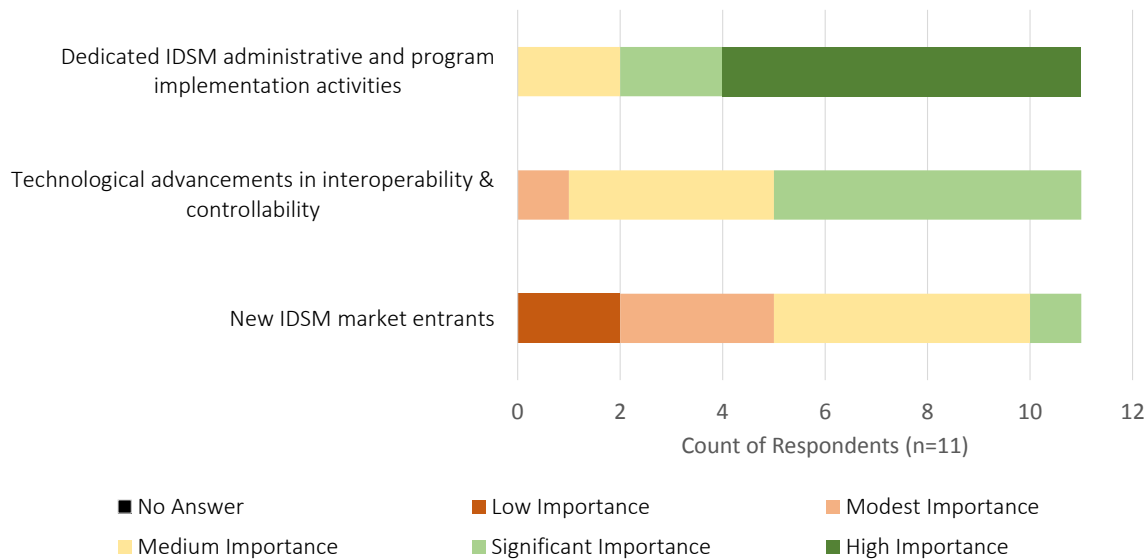


Figure 7: Internal Opportunities to Expand IDSM Programs

7.1.1 Dedicated IDSM Administrative and Program Implementation Activities

Respondents indicated that they believe that IDSM has the potential to improve the cost-effectiveness of delivering EE, DR and other program offerings for customers and program administrators, as well improving the operation of end uses at the service premise. Eight of 11 respondents indicated they had already undertaken some internal reorganization to consolidate DSM program areas (see Figure 6), although a majority of respondents indicated there remained ample opportunity for further reorganization (see Figure 7). Specifically, more than two-thirds of the respondents indicated that establishing dedicated IDSM administrative resources and program implementation activities within their organization was of the highest importance for expanding IDSM portfolios, while the other third indicated that it was of medium and significant importance.

In follow up interviews program administrator staff suggested that the development of cross-business functional teams should enable cross-training of expertise for multiple DSM measures and programs, and foster collaborative and innovative development of new IDSM programs and delivery mechanisms. Interviewees also noted that such a reorganization should also allow the IDSM team the flexibility and ability to identify new opportunities and provide management with an opportunity to assist the team in removing barriers to broader and deeper integration. For example, DSM programmatic efforts could be

reorganized around portfolios of measures that fit certain types of customers. SMUD has implemented such an approach in a recent reorganization effort that seeks to categorize customers in their service territory based on a myriad of factors including geographic location, demographics/firmographics, prior DSM experience, etc. to identify viable DSM measures that fit each customer category's needs and then aligning their internal program structure around these customer groupings and their associated portfolio of integrated DSM technology offerings. SMUD noted that the re-organization and integration of DSM planning, administrative services, and funding requires the support of upper management within the utility organization.

7.1.2 Technological Advancements in Interoperability and Controllability

Most respondents agreed that they needed to support industry as well as internal efforts to advance interoperability and controllability of the IDSM measures in order to successfully expand IDSM opportunities in their service territories (see Figure 7). Automated energy management technologies that are part of an IDSM portfolio have potential for managing energy consumption temporally and geographically for all customers sectors. Automating efficient end-uses that can respond to price or market signals with little or no disruption to customers, are promising opportunities. However, constraints on interoperability and controllability of automated solutions have created some barriers to mass deployment of these enabled measures, as indicated by the survey respondents. The use of open communication standards, such as OpenADR, can help facilitate interoperability and controllability and it is becoming increasingly common for manufacturers of enabling technologies to produce equipment that are compatible with OpenADR protocol software.

Utilities and third-party program administrators drive the technology market with their purchasing decisions for automated technologies. These organizations can work with technology vendors to establish protocols and open standard criteria that will improve interoperability and controllability of measures. Technology vendors can adapt platforms and resource interfaces to advance the performance of the technologies, based on the feedback and requests of the program administrators.

To this end, interviews with our respondents indicated that program administrators should test a technology's interoperability with their internal systems, like OpenADR, a Demand Response Management Systems (DRMS), or a Distributed Energy Resource Management Systems (DERMS) and work with vendors to support that effort. Such efforts could help ensure compatibility and controllability between the open protocols and DRMS or DERMS solutions and the selected technologies controlled through the system.

Program administrators also suggested that working more closely with technology vendors and trade groups to encourage the use of standards-based protocols could improve interoperability, communication, and controllability. Program administrators can influence the development and advancement of the technology vendors' enabling technologies by clearly indicating performance needs. Vendors will often comply and work with utilities and third-party administrators to develop solutions that the program administrators will adopt.

7.1.3 Opportunities for New IDSM Market Entrants

Nine of the 11 respondents indicated that expanding opportunities for new IDSM market entrants, such as ESCOs, technology vendors and program implementers were of modest to significant importance (see Figure 7). Interviews with program administrators suggested that one barrier to integration of DSM is the lack of third-party implementers, ESCOs and contractors with cross-program missions and

skills.³¹ Procurement, training and outreach coupled with financial incentives offered by the program administrators with the goal of integration, combined with programs and projects requiring integrated contracting skills, could encourage the development of new motivation and skill sets among third-party implementers, ESCOs and contractors. However, without coordinated program design and process, vendors may face conflicting priorities if they are under contract with the utility for one program (e.g., energy efficiency) and don't get additively compensated for offering additional products (e.g., DR) to customers (Leuschner et al., 2016).

In interviews program administrators suggested that there are benefits to be had if ESCOs, aggregators or program implementers play a collaborative role with the program administrator; such collaboration could be most effective if defined and instituted during the program design phase. Co-branding and joint development of marketing and education material could also be beneficial.

7.2 Regulatory Opportunities

Our survey also inquired about the importance of various opportunities for external (i.e., regulatory) entities to promote increased deployment of IDSM, based on the assumption that program administrators' own internal efforts might need to be augmented with regulatory changes. Respondents indicated that the most significant opportunities for regulatory reform would address: 1) separate and distinct program budgets; 2) effective metrics for evaluating cost-effectiveness; and, 3) to a slightly lesser extent, regulatory rules for EM&V (see Figure 8). Each regulatory reform opportunity is discussed in more detail below.

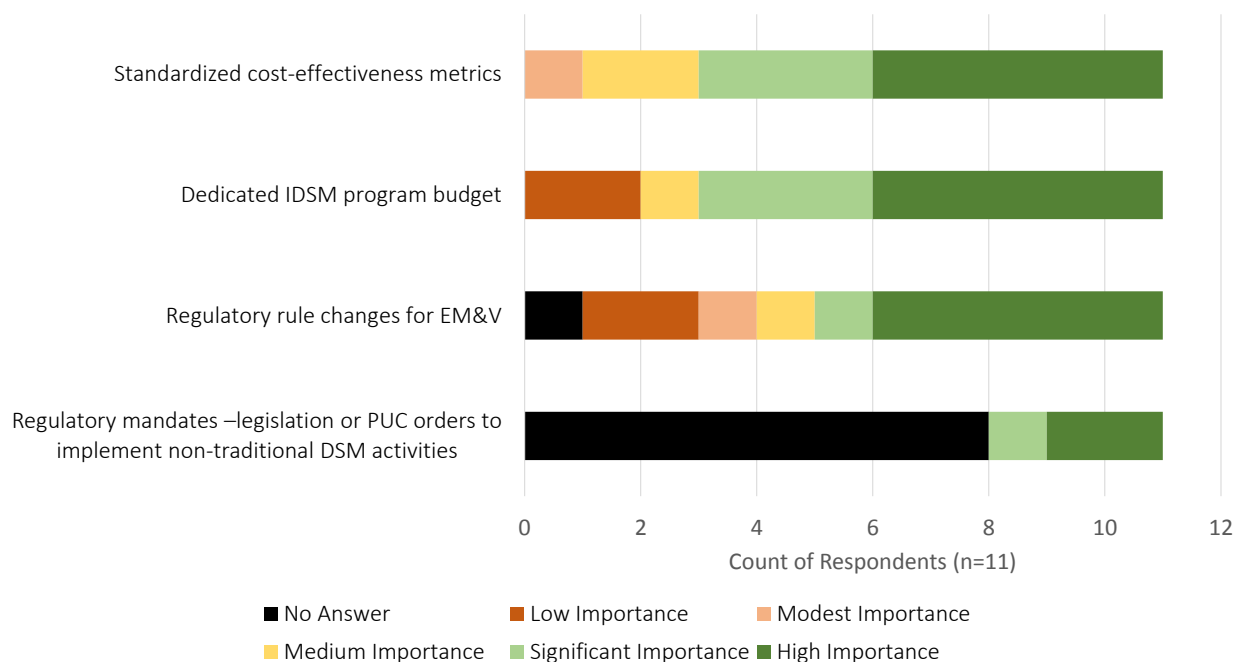


Figure 8: Regulatory Opportunities for Expanding IDSM Portfolios

³¹ In our interviews with several ESCOs, the companies indicated that they put concerted effort into educating customers about comprehensive integrated solutions. The ESCOs work to implement turnkey solutions that incorporate multiple DSM solutions including EE, DR, renewable, and storage technologies, as makes financial sense to the customer.

7.2.1 Standardized Cost-effectiveness Metrics

Respondents cited the establishment of standardized cost-effectiveness metrics for IDSM as a critical component for increasing IDSM program delivery. Approximately half of the respondents indicated that it was of high importance (see Figure 8). The other half of the respondents indicated that cost-effectiveness metrics were of modest to significant Importance. To date, program administrators contend that no common approach to valuation or cost-effectiveness has been successfully established for programs that cross disciplines, and this has presented challenges for them as they seek to develop cost-effectiveness tests for IDSM portfolio programs and projects screening.

By its nature, IDSM involves a variety of cost-effectiveness considerations that could include, for example, the impacts of interactive loads, which differ from the impacts of separately defined EE, DR, and other DSM resources. The accurate attribution of separate DSM resources, including locational and temporal differentiation, is critical to properly valuing many IDSM resources in a cost-effectiveness framework. Regulatory direction and assistance in the development of standardized cost-effectiveness metrics for IDSM programs could support development of appropriate metrics that in turn could establish the value proposition of IDSM measures and programs to both the program administrator and the customer.

7.2.2 Dedicated IDSM Program Budgets

Almost all respondents agreed that a single source of funding for IDSM programs, (i.e., a dedicated IDSM program budget), coupled with overarching goals and metrics for IDSM that focus on desired grid outcomes, could further advance the innovative design and implementation of IDSM programs (see Figure 8).³² The current structure of

separate and distinct DSM program budgets is a considerable barrier to expanding IDSM programs since funds from multiple programs must be pooled to deliver integrated measures. This limited coordination complicates the

“While IDSM may make logical sense to the DSM practitioner, the current regulatory and policy rules in place that keep EE, DR, and DG separate will continue to prohibit the development of innovative programs designs that promote IDSM” – Southern California Edison

attribution of program costs and program performance, resulting in program administrators typically avoiding such programmatic complications.

7.2.3 Regulatory Rule Changes for IDSM EM&V

Seven of 11 program administrators indicated that changes to regulatory rules for IDSM EM&V processes was of at least medium importance for accelerating the development of IDSM programs (see Figure 8). As previously mentioned (see Section 5.1.2), approximately half of the program administrators we surveyed indicated that they evaluate the performance of their IDSM portfolios. Of those that do, evaluation efforts develop performance metrics consistent with each DSM program independently, such as EE (kWh) then DR (kW), and do not examine the performance of the IDSM portfolio holistically. Many of the respondents indicated that they did not believe the current DSM EM&V frameworks were adequate for capturing the holistic energy, demand, and other benefits offered by IDSM programs. During interviews, one program administrator suggested that a pay-for-performance type structure could offer a potential solution to EM&V challenges for IDSM.

³² Dedicated IDSM program budgets can help facilitate the deployment of IDSM programs but they are one of many components necessary to get the desired outcomes. It's a necessary but not a sufficient condition to solve the IDSM problem.

7.2.4 Regulatory Mandates

Although a majority of respondents did not provide any answer concerning the importance of regulatory mandates on their future ability to successfully expand IDSM offerings, three respondents indicated such mandates were vital (see Figure 8).

These three particular program administrators indicated that regulatory mandates, integrated program funding, and oversight for IDSM programs are all critical to the success of their IDSM programs. For example, Con Edison reported that the New York PSC's *Reforming the Energy Vision* (REV) Initiative provided the impetus for several of the

IDSM programs that are currently offered as pilots or demonstration projects in their service territory. In particular, the PSC ordered all utilities to file pilot and demonstration projects (NYPSC, 2015b). In addition, New York State Energy Research and Development Authority established

"The advancement of technology-agnostic, grid service-based tariffs will also play a key factor in the evolution of IDSM. The regulatory environment can help support the interdependent nature of IDSM within these service categories, set mandates, and work with the administering parties to prioritize the multiple goals that may result from the various directives." – Hawaiian Electric Company

several funding opportunities to support these pilot and demonstration projects. In response to these regulatory efforts, Con Edison's local generation incentive programs target combined heat and power, solar, wind, and other renewable energy and energy efficiency projects, and offer premium incentives for businesses in specific neighborhoods, such as the Brooklyn-Queens areas of New York City where utility load forecasts have indicated the distribution system will exceed current system capacity on peak demand days (Coddington et al., 2017). These programs are sanctioned by the New York Public Service Commission and allow for dedicated program budgets, administration, and oversight. The regulatory mandates for IDSM help facilitate delivery of these programs, providing direction for the integration of DSM programs.

8. Optimal Future IDSM Portfolios

We asked the program administrators who participated in our study to consider what specific mix of measures and technologies (i.e., strategies) have the most potential for adoption in an IDSM portfolio in the near future (see Table 2 for residential programs and Table 3 for commercial and industrial customer programs). The first column lists the strategies that the program administrator respondents listed as the most promising opportunities and technologies for IDSM. In the second column, we provide a description of those strategies, most of which are available today.

Several appear poised to pursue greater coordination of existing DSM programs with those that target the electrification of the transportation sector (e.g., electric vehicles, electrified public buses). The respondents also concurred that the market for the Internet of Things (IoT) connected devices and appliances will continue to expand and offer opportunities for program administrators to connect with customers and their end-uses. These IDSM measures and resources can provide flexible energy management, as described in the second column, and could potentially provide value to the customer, program administrator, and grid if integrated successfully.

Subsequent interviews revealed that the focus for many respondents going forward is finding the technology combinations that will provide necessary grid services, and then building IDSM programs around those needs. For example, SMUD stated that targeting customers that already have solar and offering smart thermostats and storage was a strategy on the table for helping to manage grid impacts of high penetrations of rooftop solar PV. The program administrator also aspires to develop an IDSM program offering to customers which combines solar, storage, DR and TBR has the potential to defer distribution upgrades in their service territory. Furthermore, SMUD believes that implementing IDSM programs that integrate EVs with smart chargers, solar and storage can reduce evening peaks and provide other grid services.

Table 2: Promising Residential IDSM Programmatic Opportunities

Strategy	Description
Home Retrofit	Home retrofits programs that include incentives for a bundle of DSM improvements including, but not limited to: home weatherization, appliance upgrades, lighting retrofits, installation of technologies that enable demand response (e.g. home energy management systems and sensors, PCT), EV charging panel, and DG.
HVAC Controls	Wi-Fi connected programmable communicating thermostats can be enabled to receive a DR signal during an event, provide the customer with long-term efficiency savings, and respond to time-based rates via automated controls and sensors.
Water Heating	<p>Heat pump water heaters (HPWH) use electricity to move heat from one place to another instead of generating heat directly. Therefore, they can be two to three times more energy efficient than conventional electric resistance water heaters. Additionally, HPWH have demonstrated that they are capable of providing demand response services.</p> <p>Grid-interactive water heaters (GIWH) adds bi-directional controls to electric resistance water heaters, and are capable of allowing the utility or third-party aggregator to rapidly and repeatedly turn them on and off, or incrementally ramp their power up and down. This control creates an opportunity to utilize the GIWH as a thermal storage unit that can respond on demand to dispatch signals.</p>
Electric Vehicles	Electric vehicles and smart chargers are promising technologies that can be coordinated with TBR to receive price signals or demand response programs which dispatch control signals to charging stations. The charging stations can respond to price or program signals by increasing or decreasing load in response to grid needs, and can be paired with solar PV or storage systems for more optimal charging behaviors.
Advanced Solar Inverters	Smart solar inverters that are capable of sending and receiving data from the utility or third-party aggregator systems and providing advanced grid functions, such as ramp rate control, power curtailment, fault ride-through and voltage support.
Battery Storage	Battery storage was cited by all participants as the most promising IDSM technology. Battery storage combined with DG could provide greater grid stability and optimize behind the meter resources. If paired with a time-based rate, storage can also take advantage of energy arbitrage opportunities.

Table 3: Promising Commercial and Industrial IDSM Programmatic Opportunities

Strategy	Description
Lighting Systems and Controls	Networked Lighting controls in commercial buildings can provide dramatic energy reductions, in particular during evening hours when the buildings become vacant and workers go home. Networked controls use sensors to maintain lighting only where there is occupancy and can also be used to control lighting during DR events, using dimming and daylight harvesting strategies, and/or in response to TBR.
Retro-Commissioning	Retro-commissioning programs begin with an audit of the entire facility to determine what equipment and envelope measures need to be addressed. IDSM opportunities for retro-commissioning can offer incentives for EE measures (e.g. lighting retrofits, building automation upgrades, HVAC improvements, variable frequency drives), demand response technologies, and DG (if applicable)
Energy Management Control Systems	Building Automation Systems (BAS) or Commercial Energy Management Control Systems (EMCS) are computerized control systems that regulate the energy consumption of a building by controlling the operation of end-uses, such as the heating, ventilation and air conditioning (HVAC), lighting, and water heating systems. This creates numerous opportunities for more efficient operations, control during DR events, and response to TBR.
Battery Storage	Battery storage was cited by all participants as the most promising IDSM technology. Battery storage combined with DG and DR could provide greater grid stability and optimize behind the meter resources. If paired with a time-based rate, storage can also take advantage of energy arbitrage opportunities.
Electrified Public Buses	Electrified public bus transportation is noted as an opportunity to change the fuel source of public transportation and utilize the buses as energy resources on the grid, such as charging mid-day when solar production is highest, through either DR or TBR. This also creates opportunities for greater efficient use of energy, writ large.

9. Conclusion

The electric industry has long recognized the value of improving the integration and coordination of DSM program delivery from an aspirational policy perspective, but actual IDSM program implementation is nascent. The eight program administrators (comprised of 11 survey respondents) who participated in this study stated that key value drivers for IDSM include: 1) ability to deliver more or a broader range of demand side technology combinations and services that are capable of optimizing customers' end-use energy consumption; 2) opportunity for increased customer engagement and satisfaction; and 3) compliance with regulatory mandates to offer IDSM or coordinated EE and DR programs.³³ Over half of the respondents indicated that IDSM opportunities have the potential to help address distribution and in some cases bulk power system needs by providing targeted, locational and temporal controllability and/or energy reduction of energy consuming devices.

IDSM programs are still in the early development stages for most utilities that are attempting to implement them. Programs are being developed that include solar, storage, smart inverters, EVs, EE and DR, but they tend to be pilots or demonstrations, with only a few large-scale deployments of IDSM programs, as we have defined them, to date. Demonstration and pilot projects can lay the foundation for future IDSM program designs by providing verification of customer end-use savings and control, as well as grid impacts - elements crucial for gaining both external (e.g., regulatory, stakeholder) and internal (e.g., executive management, program managers) support for such endeavors.

From the perspective of those program administrators who participated in our study, deployment of more complex IDSM programs over the next few years could be expected. The costs are declining rapidly for IDSM measures (e.g., PV and smart inverters, battery storage, electric vehicles, communications/control devices and software), making them more attractive to customers (SEPA and Black & Veatch, 2017), which could help encourage IDSM program participation in the coming years. However, the respondents also identified and prioritized a myriad of barriers that may limit their ability to expand IDSM offerings. They recognize that it will require both internal and external leadership to adequately address and overcome these barriers and subsequently capture the benefits that IDSM enables.

³³ For example, Evergreen Economics (2016) studied outcomes in California for IDSM customer participants compared to customers that implemented only EE. The study found that customers who installed EE as part of participating in an IDSM program (in this case, solar PV plus energy efficiency) said they were more satisfied with the performance of their EE improvements than those who did energy efficiency improvements alone.

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Appendix A. IDSM Data Collection Tool

Barriers and Opportunities for Broader Adoption of Integrated Demand Side Management (IDSM) Practices

Lawrence Berkeley National Laboratory (LBNL) is collecting information from utility demand-side management practitioners. The results will inform a U.S. DOE-funded study on the opportunities and barriers for Integrated Demand Side Management (IDSM) in the Residential, Commercial, and Industrial customer sectors. Your participation in this data gathering exercise will help LBNL accurately characterize current definitions, practices, potential benefits and barriers to broader adoption of IDSM. This information will be used to create case studies on the participating utilities and be presented as a scoping study report to inform utilities, regulators and other stakeholders. The results are planned for release in late fall of 2017.

Program Type Definitions.

To provide similar context for all participants, we offer the following definitions of the different program types that may fall under the rubric of IDSM or integrated distributed energy resources (DER) program deliver. These can apply to utility or third party administrator programs for the Residential, Commercial, and Industrial customer sectors that may be funded by ratepayer charges, through public benefits funds, rate cases or other means.

- Demand Response (DR): programs that incentivize customers to adopt control technologies that can shift or shed load. For example, programs that utilize control technologies, such as smart thermostats, direct load control switches, plug load controls, or automated demand response (ADR) technologies, and/or behavior based DR programs.
- Distributed Generation (DG): programs that incentivize customer adoption of DG technologies, such as photovoltaics, fuel cells, combined heat power, small wind turbines.
- Storage: programs that incentivize customer deployment of storage technologies, such as Li-ion and other types of batteries, grid-integrated electric water heaters, commercial and residential thermal energy storage (TES), and, in some cases, grid-integrated EV smart chargers.
- Energy Efficiency (EE): programs that incentivize deployment of EE technologies and behaviors. These can include upstream, midstream, or downstream rebates/incentives for equipment (e.g., HVAC, lighting, appliances, envelope measures, and boilers) and other energy efficiency programs such as custom rebates.
- Time-Based Rates (TBR): Electricity rates paid by customers in which rates vary for different days, times of the day, or events (such as days with extremely high loads). Examples of pricing programs: Time of Use (TOU) where the day is divided into blocks of hours and the kWh price varies between blocks. Critical Peak Pricing (CPP): Very high prices are applied on a small number of “event” days during a year. Real-Time Pricing (RTP): Prices vary by hour.
- Electric Vehicle (EV): programs that provide incentives for deployment of grid-integrated EV smart chargers (if separate from the storage program), or offer special TBR to encourage specific charging behavior.

- 1. IDSM Definition.** In your organization or for the industry at large, how do you define integrated demand-side management? We have provided several definitions in the table below. Please mark the one choice that is most applicable, or add your own definition in the space provided.

Definition of IDSM

Mark “X” for the one that applies best

Integration/coordination of one or more components (i.e., funding, administration, incentives, outreach/marketing, and multi-purpose technologies) of your energy efficiency, time-based rates, and/or demand response programs; excludes distributed generation and storage.

The integration/coordination of one or more program components (i.e., funding, administration, incentives, outreach/marketing, multi-purpose technologies) for three or more of your: (1) EE, (2) DR, (3) DG, (4) Storage (ST), and (5) TBR programs.

Integration of multiple, interrelated end-use measures across more than one discipline, (“Discipline” refers to the industry trades (e.g., electrical [lighting], heating, ventilation and air conditioning (HVAC), construction). Under this definition, lighting with ADR controls wouldn’t be considered IDSM, but lighting with ADR controls installed with a HVAC with ventilation fan controls would be considered IDSM.

Your definition, if different from any of the above _____

- 2. IDSM Drivers.** What are the drivers/potential benefits that motivated your organization, regulators, policymakers, and stakeholder to pursue IDSM? (Check all that apply)

Drivers/Objectives for Implementing IDSM

Mark “X” for all that apply

Ability to deliver increased number or broader range of demand side technology options and services that are capable of optimizing customers’ end-use energy consumption

Reducing the market confusion that customers might experience about different demand side program offerings

Compliance with regulatory mandates to offer IDSM

Ability to deliver IDSM that better meets locational and/or temporal grid needs

Ability to improve program delivery cost-effectiveness

Increasing customer engagement and satisfaction

Other (please describe) _____

Other (please describe) _____

3. Current IDSM Program Activities

- a. We have attached a worksheet containing a list of your utilities' current IDSM offerings. We have populated the spreadsheet with information about your programs based on material found on your website. Please review the list to correct and complete any information we may not have correctly captured, including any of your programs we may have missed.
- b. In order to implement your IDSM program(s), what activities has your organization undertaken – if anything? (Check all that apply).

IDSM Program Activities Undertaken by Our Organization

Mark "X" for all that apply

Funding for some/all DSM programs has been consolidated and integrated.

Responsibilities for delivering some/all DSM technologies have been consolidated to one or a smaller number of different organizations in the market, e.g., aggregators, program administrators.

Responsibilities for delivering some/all DSM technologies have been consolidated to one or a smaller number of departments within my organization.

Developed education and outreach material that combined information about different DSM technologies and measures that historically fell under different program types to help customers gain knowledge about value of investing in several different DSM technologies coincidentally

Developed and transitioned, or are in the process of transitioning, customers to retail rates that align with IDSM objectives (this could include active or pending proceedings and/or rate cases)

Created internal and external training opportunities to increase utility staff and contractor capabilities in different IDSM technologies

Other (please describe) _____

Other (please describe) _____

c. Program Evaluation and Performance

- i. Do you evaluate or measure the performance of your IDSM programs? (yes/no) _____
- ii. If the answer above is yes, how do you approach evaluation and/or what metrics do you use? Do you explicitly look at kWh, kW, GHG impacts, societal costs, cost-effectiveness tests of any kind for IDSM– or are you working on ways to do this in the future?

(Please put your answer here.)

- iii. Do your organization's current outcome metrics fall short in measuring **IDSM** program performance? (yes/no) _____

iv. If so, how?

(Please put your answer here.)

4. Outcomes and Benefits of IDSM Efforts

- a. If your organization has IDSM programs, can you describe what outcomes are unique from DSM programs that are administered independently? What are the benefits of IDSM that can't be delivered through separate programs?

(Please put your answer here. Use as much space as you need.)

- b. Based on your experience to date, have you seen evidence that IDSM is beginning to achieve the benefits that motivated implementing the programs? (yes/no) _ _
- c. If yes, please indicate in the table below which benefits/objectives are materializing or showing potential to materialize? (Please mark all that apply)

Benefits Materializing or Showing Potential to Materialize

Mark "X" for all that apply

Saving more energy/helping to meet EE targets beyond what EE programs can deliver alone

Reducing peak demand beyond what DR programs can deliver alone

Improving the cost-effectiveness of DSM programs

Reducing customer confusion around DSM program

Increasing customer participation in DSM programs/delivering DSM to more customers

Addressing locational and/or temporal grid needs

Other (please specify) _____

Other (please specify) _____

5. Barriers and Challenges

- a. If your organization has not implemented as many IDSM programs as you think there is potential for - why not?

(Please put your answer here.)

- b. In the table below, please rate on a scale of 1 to 5 (1= low, 5= high) the extent to which each of these barriers limits the ability to broaden offerings of IDSM.

Barriers to Offering or Expanding IDSM

Rate on scale of 1 to 5
1 = not significant barrier
5 = barrier to high extent

Separation of responsibilities within organizations for delivering different DSM technologies (e.g., EE department, rates department, DG department, etc.)	
Separation of responsibilities across industry partner organizations for delivering different DSM technologies (e.g., utility, third-parties, etc.)	
Separate/distinct program budgets for EE, DG, DR, and Storage	
Regulatory rules for EM&V (lack of integrated rules)	
Lack of effective metrics for evaluating cost-effectiveness of integrated programs	
Customer market confusion about program & technology offerings	
Technological interoperability	
Technological controllability	
Telemetry requirements &/or functionality	
Other market barriers (please describe) _____	

(Please provide any additional comments on barriers here.)

- c. In your opinion, is it difficult to measure the success of IDSM efforts or describe what success looks like? (yes/no) _____
- If yes, can you briefly describe why it is so difficult?
 - If no, can you please describe how the industry can measure and describe the success of IDSM?

(Please put your answer here.)

6. Lessons Learned from Current IDSM Efforts

- a. In the table below, please describe any lessons learned and/or best practices you've observed from your IDSM efforts to date for each of the topics listed, as applicable.

<i>Topics Related to IDSM Efforts</i>	<i>Lessons Learned (provide description for any that apply)</i>
Internal organization/ administrative structure	
Regulatory reform	
Program design	
EM&V approach / evaluation metrics	
Marketing and education	
Interoperability of technology, etc.	
Other (please specify)	
Other (please specify)	

7. Future Opportunities

In this section, we ask you to think about the opportunities for IDSM in the coming decade. Please feel free to add your own thoughts and ideas in addition to the guided questions below.

- a. How important are each of the components listed below to creating or expanding opportunities for successful delivery of IDSM technologies? In the table below please rate each component on a scale of 1 = low importance to 5 = high importance, or N/A= Not applicable, 6 = Already done)

<i>Critical Components Needed for Expanding IDSM</i>	<i>Rate on scale of 1 to 5, where 1 = low importance to 5 = high importance, or 6= Already done, or N/A</i>
Dedicated IDSM administrative and program implementation activities	
Dedicated IDSM program budget	
Regulatory rule changes for EM&V	
Standardized cost-effectiveness metrics	
New IDSM market entrants	
Technological advancements in interoperability & controllability	
Other (please specify) _____	
Other (please specify) _____	

- b. In your opinion, what changes in the regulatory environment (i.e. Energy office, Public Utility Commission, ISO/RTO market rules) in the next 10 years could create or expand opportunities for your utility to further advance your IDSM offerings? (Open-ended answer)

(Please put your answer here.)

- c. Other than Smart Thermostats, what end-uses and technologies do you foresee as the most promising (low hanging fruit) for IDSM portfolios? Alternatively, what currently available technologies are you looking at that could benefit your utility's IDSM efforts in the near term?

(Please put your answer here.)

- a. What are the most promising programmatic opportunities you foresee for integration of DER (e.g., storage, electric vehicles) and EE or DR technologies? For example, deploying grid integrated smart EV chargers with DR capabilities to respond to T&D system events, or deploying grid integrated smart PV and DR-capable battery storage inverters at specific customer locations to manage grid needs.

(Please put your answer here.)

Thank you for taking the time to participate. The information you have provided will help LBNL, and the U.S. Department of Energy continue to evaluate emerging demand side management and grid needs trends.

Appendix B. Recent Regulatory Activity on IDSM

Electric utility regulatory policies are designed to respond, both proactively and reactively, to challenges in the industry. Over the last decade, many states have developed policies to address load growth, peak demand, and climate change, among others. Many of these policies and mandates include renewable portfolio standards and targets for EE savings (Durkay, 2017). These policies can include a portfolio of required programs and/or initiatives for achieving each mandate, but few states have focused on specific mandates for IDSM or IDER.

There are three states that are leading the way with regulatory reforms that include IDSM in their market transformation efforts: California, New York, and Hawaii. While each state has different market structures, they each share three common policy goals: improved grid resiliency/reliability; reaching environmental targets; and reducing customers' energy cost (Fine et al., 2015).

B.1. California

California regulators have been working on their IDSM initiatives for almost a decade. They have long seen the importance of an IDSM portfolio of programs, but have had considerable challenges in establishing cost-effectiveness test for IDSM programs as well as difficulty creating metrics for which to evaluate the performance of these integrated programs. However, significant strides have been made in establishing definitions and developing a framework for cost-effectiveness, although no process for determining the value of these programs has been decided upon. In 2011, the CPUC established an IDSM Task Force, which included the investor-owned utilities: Pacific Gas & Electric Company, San Diego Gas & Electric, Southern California Edison, Southern California Gas Company (CPUC, 2009). The IDSM Task Force was asked to explore the development of an integrated approach to the cost-effectiveness of demand-side management programs and projects:

"To effectively integrate DSM program design, a set of internally consistent proposed cost-effectiveness methodologies need to be developed for integrated projects, and for program efforts that seek to combine all of these demand side resource options within an integrated portfolio." (CPUC, 2012)

The California IDSM Task Force recommended that the Standard Practices Manual (SPM) be used to assess each measure using a set of methods that extend beyond avoided cost calculations. The outcome of the study determine that the SPM be updated with new processes and methods "to provide an optimal approach for IDSM cost-effectiveness" (Black & Veatch, 2011).

California policymakers are also focused on a clear set of state policy objectives related to the role of DERs, increasingly aggressive renewable targets, and GHG reduction goals. While California regulators are making strides to create an integrated grid, there is a near-term focus on managing DER growth. This emphasis has led to the enactment of state law AB 327 creating Public Utilities Code §769. The law mandates that California investor-owned utilities (IOUs) file distribution resource plans (DRP) to integrate distributed, customer-owned resources into grid investment and operational plans. California is in the process of evolving its IDSM efforts, including potentially concentrating its IDSM efforts for the near term to focus on just EE and DR in an effort to more quickly provide flexible grid resources. In June 2017 the CPUC proposed reducing the scope of its IDSM program and repurposing the IDSM budget to

fund a limited integration of EE and DR through two specific technologies only: HVAC and lighting controls, in addition to supporting analysis under the IRP process. The rationale is that these technologies are easily utility-controlled, can manage energy use on a locational and time-of-day basis, and are minimally impactful on customers (CPUC, 2017b).

B.2. New York

The State of New York has introduced several initiatives that focus on the integration of DSM measures in order to achieve a resilient and reliable grid, meeting environmental targets for GHG reduction and renewable energy resources. The New York *Reforming the Energy Vision* (REV) initiative and the New York State Energy Research and Development Authority's (NYSERDA) Clean Energy Fund were established, in part, to accelerate adoption of renewable energy resources, EE, and emerging technologies that support the state's Renewable Portfolio Standard and economic growth initiatives. Under the policy framework of REV, the New York Public Service Commission issued an order which provides a regulatory mandate to utilities and energy service providers throughout the state to develop IDSM programs that support the initiative (NYPSC, 2015b).

In April 2017, NYSEDA announced that a total of \$15.5 million in funding available for energy storage projects that can "support renewable energy technologies, save customers money, and ease peak electric demand burdens on the power grid" (NYSEDA, 2017). Furthermore, NYSEDA also launched NextGen HVAC Technology Challenge, a three-year initiative aimed to expand and promote innovation for new HVAC technologies, including control technologies and advanced cold climate heat pumps (NYSEDA, 2017). These funding opportunities are an extension of REV's policy initiative to drive market innovation for integrated technologies and solutions that can fulfill the objectives of REV. NYSEDA's investments in advanced technologies has the potential to move the market towards greater adoption of IDSM portfolios.

B.3. Hawaii

Hawaii's regulators are similarly developing innovative policies in response to market developments. In addition to Hawaii's aggressive 100% RPS by 2045 (State of Hawaii, 2015), policymakers are focused on managing energy costs for consumers. The policy focus in recent years has been on grid reliability and resiliency given the high penetration of rooftop solar systems throughout the state. One out of every eight homes in Hawaii now has solar, which is leading to overvoltage and utility restrictions on further PV deployment.³⁴ In response, Hawaii's Public Utility Commission (HPUC) issued four orders, including Order No. 32052 (HPUC, 2014) that requires utilities to file distributed generation interconnection plans (DGIPs) to upgrade distribution circuits and to integrate more PV using demand side resources, namely EE and DR.

In August 2017, Hawaiian Electric Companies' filed a Grid Modernization Plan that requests funding for customer-sited storage, targeted deployment of smart meters, advanced demand response technologies, and distribution automation, amongst others (HECO, 2017). The HPUC had requested the Grid Modernization Plan to provide a plan to build a more resilient grid while meeting the state's 100%

³⁴ This abundance of solar generation has caused distribution circuits to back-feed during times of high utilization (Fine et al., 2015).

renewables by 2045 mandate (HPUC, 2017a). HECO's filing included these IDSM technologies and strategies to help meet the current state goals and maintain reliability on the grid.